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THE DETERMINATION OF E/M FOR CATHODE RAYS AS A LABORATORY EXPERIMENT FOR AN UNDERGRADUATE COURSE IN ELECTRICAL MEASUREMENTS.

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The numerical value of the ratio of the charge to the mass of the cathode ray particle or electron is no longer a problem for the research laboratory. It is as truly a constant as is the heat of fusion of ice, or Joule's mechanical equivalent, and its value is nearly as accurately known. However, its experimental determination is generally considered to be fraught with manipulative difficulties of considerable moment, which under the ordinary conditions of laboratory equipment makes it an extremely difficult, if not an impossible, experiment for undergraduates.

The recent development of the electron theory with its bearing upon the nature of electricity and the probable constitution of matter is so fundamental and far-reaching that it seems quite proper that one or more of these comparatively new and yet apparently more difficult experiments should be included in an undergraduate course in electrical measurements. Hence the following elementary theory for the determination of e/m for cathode rays is presented as an instructive and practical experiment. For pedagogical reasons the discussion is given as recently presented to a class in electrical measurements for juniors. The apparatus necessary consists of a Braun tube having a pair of electrostatic field plates inside, a three-inch induction coil, and a high potential battery capable of furnishing potential differences up to 500 volts, also a commutator, a simple water resistance and a voltmeter.

The more important characteristic properties of the cathode rays are—they travel in straight lines and have a high velocity, the electrons composing the rays each carry a negative elementary charge, they are deflected by either a magnetic or an electrostatic field, they apparently have a mass that is 1/1700 that of the hydrogen atom, they may ionize a gas through which they pass,

and upon striking an object they cause that object to emit Roentgen rays.

The charge on the electron and the mass of the electron are severally quite difficult to determine. However, their ratio, e/m, is comparatively easy of measurement. The velocity of the electron also admits of easy measurement. In the theory that follows, the property of the magnetic and electrostatic deflection of these rays is employed.

(a.) ELECTROSTATIC DEFLECTION OF A MOVING ELECTRON.[1]

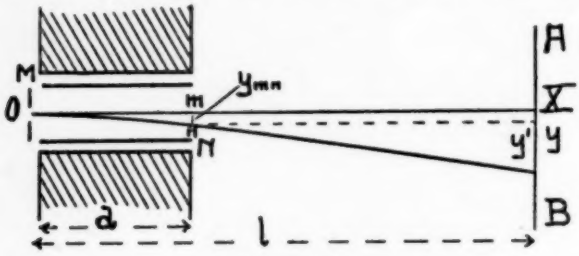

FIGURE 1.

In Figure 1 let

OX = path of undeflected beam.
MN = electrostatic field plates.
AB = screen.
Y = electric force per cm. between plates.
d = length of field plates.
l = distance of screen from opening O in diaphragm.
y = electrostatic deflection on screen.

Let the lower plate be charged positively and the upper one negatively, and suppose that the field ends abruptly at the edge of the plates (the error is quite negligible if the plates are close together). The electron in moving through the uniform electric field is urged toward the positive plate with a force Ye, and its equation of motion is

$$m\frac{d^2y}{dt^2} = Ye$$

where $\frac{d^2y}{dt^2}$ is its acceleration in the y-direction. From which

$$\text{Accel.} = \frac{Ye}{m} = a.$$

Applying the laws of falling bodies, the deflection becomes

$$y_{mn} = \frac{1}{2}at^2 = \frac{1}{2} \cdot \frac{Ye}{m} \cdot \frac{d^2}{v^2},$$

[1]Thomson, *Conduction of Electricity through Gases*, 2d Ed., p. 117.

and the velocity downward is given by

$$v_{mn} = at = \frac{Ye}{m} \cdot \frac{d}{v} .$$

The path of the electron from the edge of the field plates to the screen AB is a straight line, hence the additional deflection downward in traveling this distance is

$$y' = v_{mn} \times t' = \frac{Ye}{m} \cdot \frac{d}{v} \cdot \frac{l-d}{v} .$$

Therefore the whole distance downward is

$$y = y_{mn} + y' = \frac{1}{2} \cdot \frac{Ye}{m} \cdot \frac{d^2}{v^2} + \frac{Ye}{m} \cdot \frac{d}{v} \cdot \frac{l-d}{v}$$

$$= \frac{Ye}{mv^2} \cdot d \left(l - \frac{d}{2} \right) ,$$

which may be written,

$$y = AY \frac{e}{mv^2} , \qquad (1)$$

where A is a constant depending upon the geometrical data of the discharge tube. It should be noted that the electrostatic deflection is inversely proportional to the energy of the moving electron.

(b.) MAGNETIC DEFLECTION OF A MOVING ELECTRON.

For convenience in discussing make the magnetic field coterminous with the electric field. Let the shaded portions in Figure 1 represent the pole pieces. The magnetic lines are then parallel to electric lines of force. As in the electric case, consider that the magnetic field ends abruptly at the edge of the pole faces.

It was shown by Rowland and others that a moving charged particle is equivalent to a current of electricity, or

$$i = ev,$$

where e is the charge on the particle and v its velocity. A conductor carrying a current in a magnetic field is urged by a force at right angles to both the direction of field and current. The magnitude of this force is

$$F = Hi = Hev.$$

In a uniform magnetic field the electron, under the action of a constant force at right angles to its direction of motion, moves in a circular path. By a theorem in mechanics its normal acceleration towards the center is

$$a' = \frac{v^2}{\rho},$$

where ρ is the radius of the circle; and the force towards the center is equal to

$$\text{mass} \times \text{accel.} = \frac{mv^2}{\rho}.$$

Hence the equation of motion for a moving electron in a uniform magnetic field is

$$\frac{mv^2}{\rho} = \text{H}ev,$$

or

$$\frac{1}{\rho} = \frac{\text{H}e}{mv}.$$

This force urges the electron in the z-direction, *i. e.*, in a direction perpendicular to the plane of the paper. To evaluate $1/\rho$ construct a circle of diameter 2ρ and lay off d, the length of pole face, and z_{mn}, the magnetic deflection, as shown in Figure 2. Draw the additional lines indicated. Then, from the similar right angled triangles, it follows that

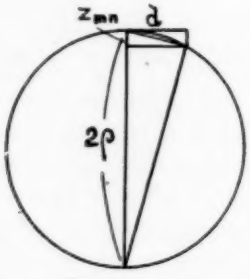

FIGURE 2.

$$\frac{z_{mn}}{\sqrt{z^2_{mn}+d^2}} = \frac{\sqrt{z^2_{mn}+d^2}}{2\rho},$$

from which

$$z_{mn} = \frac{z^2_{mn}+d^2}{2\rho} = \frac{d^2}{2\rho} \text{ approximately,}$$

since z_{mn} is small in comparison with d. Therefore

$$z_{mn} = \frac{1}{2} \cdot \frac{\text{H}e}{mv} \cdot d^2.$$

Following the same line of development as in the electrostatic case, the velocity at m, in the z-direction is given by

$$v'_{mn} = a't = \frac{v^2}{\rho} \cdot \frac{d}{v} = \frac{Hed}{m} .$$

The additional magnetic deflection is

$$z' = v'_{mn}t' = \frac{Hed}{m} \cdot \frac{l-d}{v} .$$

Hence the total magnetic deflection becomes

$$z = z'_{mn} + z' = \frac{1}{2} \cdot \frac{He}{mv} \cdot d^2 + \frac{Hed}{m} \cdot \frac{l-d}{v}$$

$$= \frac{He}{mv} \cdot d\left(l - \frac{d}{2}\right) ,$$

which may be written

$$z = B \cdot \frac{He}{mv} . \qquad (2)$$

where B, as in the electric case, is a constant depending upon the geometrical data of the discharge tube. The magnetic deflection is inversely proportional to the momentum of the moving electron. It should be remarked that both equations (1) and (2) are true for heavy carriers (atomic or molecular) having either positive or negative charges.

For coterminous fields

$$A = B.$$

By applying the two fields simultaneously and at the same time giving them the proper directions the spot on the screen will take up its position at some point P, whose co-ordinates are y, z. Obviously, under these conditions, either the velocity v, or the ratio e/m may be calculated by combining the two equations. Eliminating v between (1) and (2) gives

$$v = \frac{AYe}{mv} \cdot \frac{1}{y} = \frac{BHe}{m} \cdot \frac{1}{z} ,$$

from which

$$v = \frac{AY}{BH} \cdot \frac{z}{y} . \qquad (3)$$

Substituting this value of v in (2) and solving gives for the ratio of the charge to the mass,

$$\frac{e}{m} = \frac{AY}{B^2H^2} \cdot \frac{z^2}{y} . \qquad (4)$$

Application to the Braun Tube.

This experiment may be performed in the case of the Braun tube, by using the intensity of the *earth's* magnetism in place of

the usual solenoid or electromagnet. The relative position, for the particular tube used, of the aperature O, the electric field plates MN, and the screen AB is shown in Figure 3. From the dimensions given

$$A = d\left(l - \frac{d}{2}\right) = 8\left(32 - \frac{8}{2}\right) = 2.24 \times 10^2,$$

and

$$Y = \frac{V \times 10^8}{2.4},$$

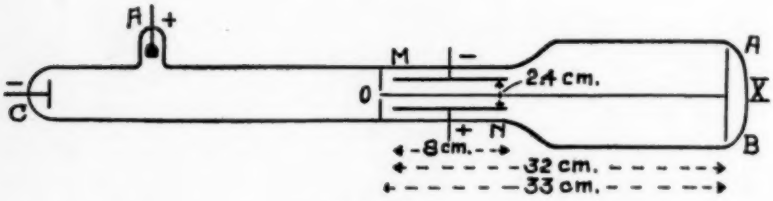

FIGURE 3.

where V is the potential difference in volts between the plates M and N.

Again, the constant B becomes, since the magnetic field acts over the entire distance OX and hence $d = l$,

$$B = \frac{l^2}{2} = \frac{33^2}{2} = 5.445 \times 10^2,$$

and

$$B^2 = 2.96 \times 10^5.$$

Equations (3) and (4) thus become, for this particular tube,

$$v = 1.71\frac{V}{H} \cdot \frac{z}{y} \cdot 10^7 \qquad (3')$$

and

$$\frac{e}{m} = 3.15\frac{V}{H^2} \cdot \frac{z^2}{y} \cdot 10^4 \qquad (4')$$

where H, as suggested above, is the magnetic field due to the earth.

Now for H either the total intensity or the horizontal component may be used. The former gives the larger deflection, however the difficulty of inclining the tube at the proper angle is considerable, especially within a building having an iron framework, hence it is more reliable and the experiment easier to perform when using the horizontal component. The vertical component, while it displaces the spot on the screen to the north or

south (depending on the orientation of the tube), introduces no error since the direction of the electrostatic field is reversed in taking readings for each position of the tube. To enable the tube to be placed in these various positions quickly and accurately it should be mounted on a wooden frame that will admit of rotation of the tube about a vertical and also a horizontal axis, as shown in Figure 4. The value of H (the horizontal component) at the point in the laboratory where the experiment was performed was previously determined by comparison with the value of H out in the open and about one mile from local magnetic disturbances, and was found to be

$$H = .160$$

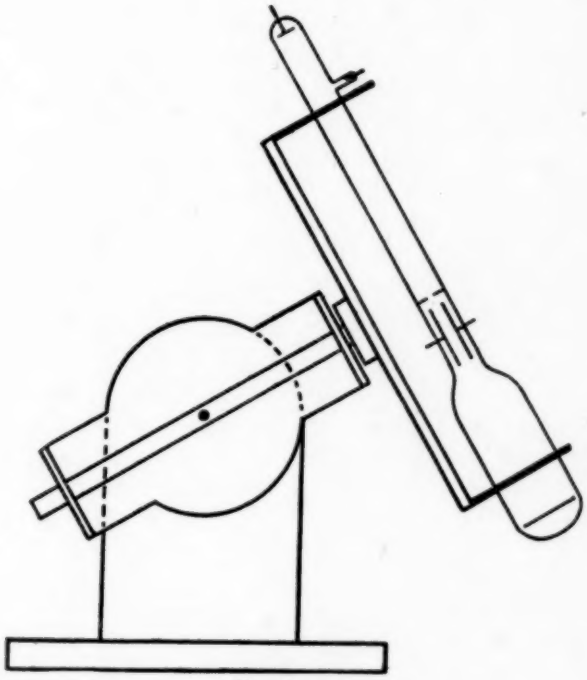

FIGURE 4.

Typical sets of data are contained in Tables I and II. The conditions that obtained in the two sets were the same with one important exception. In Table II the precaution was taken to shield that portion of the Braun tube between the cathode and the diaphragm O from the earth's magnetic field by wrapping it with two layers of annealed sheet iron. This shield was connected to earth. The effect of the shielding was quite noticeable in that the spot on the screen was brighter and steadier, thus enabling the deflections

to be more accurately read. The values of v are considerable in excess of those obtained by more refined apparatus, while the values of e/m agree indeed very closely with the generally accepted value which is 1.77×10^{7}. In fact the apparatus scarcely warrants such close agreement, yet repeated observations with widely different voltages gave values for e/m in excess but a few per cent of the true value.

TABLE I.

Readings on Screen AB. Bulb to West Direct		Bulb to West Reversed		Bulb to East Direct		Bulb to East Reversed		Mean Mag. defl. in cm.	Mean Electric defl. in cm.	V in Volts	$v\times10^{-9}$	$e/m\times10^{-7}$
Z	Y	Z	Y	Z	Y	Z	Y	x	y			
48	24	48	33	51	24	51	34	.15	.475	190	6.4	1.10
47	17	47	38	51	17	51	38	.2	1.05	372	7.5	1.74
47	14	47	43	51[2]	8[2]	51	43	.2	1.60	542	7.2	1.66
											Average,	1.50

TABLE II.

42	27	42	37.5	46	27.5	46	38	.2	.525	206	8.4	1.93
42.5	20	42.5	42	46.5	19	47.5	42	.225	1.125	409	8.7	1.78
42	14	43	47.5	47	13	48[2]	47.5	.25	1.70	625	9.8	1.84
											Average,	1.85

In conclusion it is but fair to mention that the preliminary work of testing out this experiment was ably done by F. E. Faulkner and E. A. Reid, seniors in the University. It was presented later as a regular experiment (on trial) before three sections of juniors in electrical engineeering as an experiment in electrical measurements. The accuracy of the results and the favor with which the experiment was received seem to warrant the purchase of additional tubes and making it a regular experiment to be performed by under-graduates taking a course in exact electrical measurements.

[2] Unsteady.

According to an estimate by Sir John Murray, the total annual rainfall upon all the land of the globe amounts to 29,347.4 cubic miles, and of this quantity 6,524 cubic miles drains off through rivers to the sea. A cubic mile of river water weighs, approximately, 4,205,650,000 tons, and carries in solution, on the average, about 420,000 tons of foreign matter. In all, about 2,735,000,000 tons of solid substances are thus carried annually to the ocean.—United States Geological Survey.

It is interesting to notice that the teacher of agriculture and the superintendent of the city schools where agriculture is taught are recognized by the farmers and business men as a genuine part of the community's business life by making them officers of such organizations as business men's clubs, county fairs, local products shows, committees to purchase well-bred stock, short courses and farmers' weeks. This is one of the many indications of an improved relation between home and school interests.

IS THE PRESENT ORDER OF PRESENTING THE DIVISIONS OF PHYSICS THE BEST ONE?

By C. A. Smith,
Payson High School, Utah.

It would first be well to inquire what the present order of presenting the divisions of physics is and whether or not there is a uniform order among authors in the arrangement of the subject matter of their texts. An examination of some forty text-books shows that there is a striking uniformity in beginning the subject with mechanics. But after mechanics, there is no uniformity whatever. There is, in fact, the utmost diversity, so that anything like a clear analysis is quite impossible.

Two questions arise at this point: First, why is there such perfect uniformity in putting mechanics first, and, second, why such diversity in the remainder of the divisions? The answer to the first question may be found in the reasons expressed by three of the authors whose texts were examined.

Reiche says, "That a text-book on physics conformable to nature should begin with the subject of mechanics, there can be scarcely any difference of opinion. Because shall not the principles of energy come at the beginning, so that the laws of statics and dynamics shall be deduced from their common foundation? Is not this the way of the historical development? I think it also the way in which the following laws are made most accessible. I begin the discussion with the mechanics of solids, following with Newton's First Principles, upon which I place the application of weighty problems of motion. After this has been given a great deal of thought, then the principles of energy unfold as a clear mechanical system; the cases in which mechanical energy disappear lead over into the energy of heat. Only in this way does the universal meaning of the principles of energy become marked out. They stand at the beginning of scientific investigation."

Reiche follows mechanics with light, magnetism, electricity, and heat. He says, "The laws of these subjects depend in such a way upon each other that they should be treated together, and their relation shown to energy."

Hoadley, in his *Elements of Physics,* gives practically the same reason as Reiche. He says, "The general subject of mechanics is treated early in the book, for the reason that when this subject is understood, the essential, fundamental principles of every

branch of physics is well in hand. The chapter on electricity is inserted before the one on light, so that it may be reached during the winter months of school. The atmosphere is then comparatively dry, and electrical experiments are more successful than if performed in the moister months of spring. In the longer days of spring, on the other hand, the subject of light can be studied to better advantage than in winter."

Carhart and Chute, the authors who have broken away from the established custom and reversed the order of the two subjects of mechanics, in their *First Principles of Physics*, have the following to say:

"Yielding to the advice of teachers in whose judgment the authors have the greatest confidence, a somewhat radical change has been made in the order of the subjects by placing the mechanics of fluids before the mechanics of solids. The reason assigned is that facts and principles of the former are more familiar than those of the latter; they thus form a natural approach to the abstract laws of motion, the composition and resolution of forces and velocities, and the formulae connected with them as the shorthand expression of physical laws."

It may be observed, in passing, that Millikan and Gale, in their text, *A First Course in Physics*, 1913 edition, have followed the same plan in beginning their book, and for the same reason, as Hoadley.

It will be observed that the reasons expressed by these authors are substantially the same. They may be taken, therefore, as representing the reasons in general of all the authors for placing mechanics first.

But as to the second question—Why so great a diversity in the remainder of the subjects?—no definite answer can be given because the authors, with the exception of the first two quoted, are silent as to their respective arrangements, and even between these two there is a wide difference in the reasons given, Reiche basing his arrangement on the relation which these subjects bear to one another, and Hoadley basing his on the advantage that one season of the year has over another for certain subjects. But the fact that there is so great diversity of arrangement after mechanics is significant. It shows that while there is continuity running through the entire subject uniting its several parts into one complete whole, yet these parts do not necessarily have a fixed and unchangeable position. They can be arranged in different order without doing violence to the subject as a whole. Now

Reiche makes energy the basic principle of physics. There can be no question about its being at least one of the basic principles. But even so, must it have a definite starting place, and must it follow a definite course? Is it any more fundamental in mechanics than it is in heat or electricity? Is it any simpler or any easier presented in the former than in the latter? Does the conversion of energy proceed in one direction only? Is not heat energy converted into mechanical energy as well as mechanical energy into heat energy? Is there not, in short, a free interplay among the various forms of energy? There must be or else the law of the conservation of energy breaks down. Now in every division of physics, as Reiche points out, there are laws and principles which bear a definite relation to this fundamental principle. And the relation of many of these laws and principles to the fundamental principles are identical, hence they bear a relaton to one another. May it not be possible then to take up the subject with any division and proceed on to the end and still maintain the continuity of the entire subject? The answer to this question will go a long way toward solving the whole matter. But if the subject can be begun with any division, why not leave it as it is? Why make any change? Is not mechanics as good a place to begin as any other? It may be, but the fact that the results which are secured from our high school classes are not satisfactory, in spite of improved text-books, better methods of teaching, more up-to-date and effective laboratory methods, and better equipment for both laboratory practice and class-room demonstration, must be explained. There has never been a time when the preparation of teachers was better, and when authors and publishers were exerting a greater effort to produce text-books written down to the students' level and emphasizing the practical side of the subject. But notwithstanding all that, the results have not materially improved. It is, therefore, coming to be a question whether mechanics is not too difficult a subject to start the beginner on. As Carhart and Chute suggest, the laws are abstract and the formulae hard and involved. The student is thrown into a mass of these abstract laws and required to operate with formulae, the meaning of which he has but little comprehension of before he has time to get his bearing. The result is that after struggling hard to understand what he is doing, he becomes discouraged at failure after failure and ends up in a lasting dislike for the subject. The change which Carhart and Chute have incorporated into their

new text is significant, and the impetus which led them to make the change is even more significant. It shows that teachers are beginning to think along this line and that authors are taking notice. If there could be concerted action on the part of teachers so that sufficient data could be secured, important results might without doubt be looked for.

Text-books have always been constructed according to the ideas expressed by Reiche and Hoadly, i. e., from the view point that since physics is a branch of science, it must be studied first, last, and all the time according to the rigorous methods of the scientist. It is doubtful, I believe, whether it is possible, or at least wise, to so teach it to high school students. Before fundamental laws can be understood, the facts relating to them must be mastered, not necessarily in their relation to the fundamental laws, but in their relation to one another. The student enters the class with a mind full of unorganized experiences which must be worked over into organized knowledge. This is not done by endeavoring to connect up every individual concept with the great fundamental concepts regardless of whether or not there is an experience back of it. The essential thing in all teaching is to appeal to experiences that are already in the mind, and if the experience is not there, it must first be supplied. The logical way would be to leave the more difficult and abstract concepts until other facts bearing a relation to them, either through natural laws, or at least through similarity of action, were studied. For example, it is easier to teach the law of gravity after the laws of magnetism have been studied than before, because the attraction between a piece of iron and a magnet catches the attention more quickly than the attraction of the earth and a body falling to it. True, the child has seen bodies fall to the earth all his life. His mind is filled with the experiences which come from the act of the body falling. But these are not experiences which enable him to grasp the meaning of the law. Ask him why the apple falls, and if he were to speak what were actually in his mind, he would probably tell you that it falls because there is nothing to hold it up, or if he should say that it falls on account of gravity, he would be repeating only what he had heard someone else say. It would have no meaning to him. Furthermore, the laws of gravitation as expressed by the equation $F = mm'/d^2$ is one impractical of demonstration in a high school course because the effect of gravitation on bodies which are familiarly handled by high school students is not apparent. But the nail or tack leap-

ing up from the table to meet the magnet attracts his attention, arouses his curiosity and excites his interest. By handling different magnets, he soon becomes familiar with the fact that not all magnets attract with the same force. Some, he finds, are stronger than others. By being properly directed, he finds that by separating the magnets the force of attraction decreases. Then with these facts in his mind, the law $F = pp'/d^2$ has a meaning for him. Then when he comes to the study of gravitation, although it will be none the less abstract, he will have a law which is similar in action and his mind will work much more freely. I use this illustration merely as a type. Other laws and principles in magnetism and electricity have their parallels in mechanics, which if studied in connection with the former subjects first, become easier partly because these subjects are inherently more interesting, and partly because their manifestations are more pronounced.

This, then, indicates a principle which should not be overlooked. Whatever part of physics comes closest to the student's experiences, or whatever part can most easily be drawn upon to build up experiences, is the part that should come first, would seem to be the logical conclusion.

The points to be worked out are—first, to determine whether or not mechanics is the logical starting place; second, to determine whether the laws and principles which, in the present text-books have their rise in mechanics, may not be taken up in some other division as well; third, if it is found that they can be, then to determine where best to begin; and, fourth, to fix an order for the rest of the divisions.

The working out of this plan need not change the fundamental purpose of the subject, whether it be to emphasize the practical applications of physics in everyday life, to secure interest and attractiveness, to set problems which would be significant to pupils, to point out the service of physics to mankind, or even to provide mental discipline, or prepare for college. Indeed, it is for the very purpose of making physics more effective in its applications to the student's outlook that the suggestions herein contained have been set forth.

A SIMPLE BAROMETER.

By C. C. Kiplinger,
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Some time ago, the barometer in our physical chemistry laboratory was accidentally broken and a need arose for an instrument of this type which could be easily built and which would prove efficient and accurate in operation. The barometer herewith described was constructed for the purpose of answering these requirements and its design embraces as much simplicity and ease of construction as the circumstances permitted. The instrument may be read directly to a tenth of a millimeter.

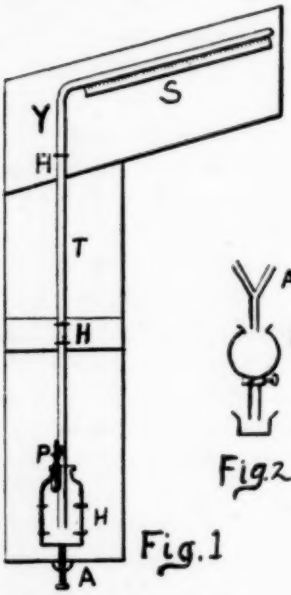


Fig. 1

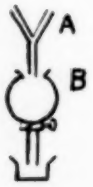


Fig. 2.

Fig. 4.

Fig. 3.

It will be noted from the accompanying sketch that the upper part of the tube is elongated and bent to such an angle that the ratio of the length of the arm to its vertical height is five to one. Hence, a rise of one millimeter in the vertical direction is equivalent to five millimeters in the bent arm. As the scale can be read easily with an accuracy of one-half millimeter, the instrument gives indications of barometric changes of one-tenth millimeter. The mercury cistern consists of a small wide-mouthed bottle held to the backboard by means of three large L-shaped curtain hooks. It rests on the small screw, A, which in turn passes through a nut soldered to a small metal plate attached to the wood

support at its lower edge. This arrangement permits of raising and lowering the cistern. The tube, T, bent as indicated, is held to the board by small curtain hooks, H, placed as shown. A half turn of the hooks allows the tube to be removed easily. P is a white glass pointer held in place on the tube with a short length of rubber tubing. A line is scratched on it to correspond with a similar line on the tube. S is a millimeter scale; an ordinary ruler serves the purpose nicely. The bent arm of the tube is about 30 centimeters in length.

Heavy glass tubing about 6 millimeters in diameter is used for the tube. This is thoroughly cleaned with potassium hydroxide and chromic acid solutions. After rinsing with distilled water, it is dried with alcohol and ether. As the final drying is a rather difficult matter, it is suggested that the glass tube be cleaned before it is bent and sealed, because it is much easier to dry an open tube than one sealed at either end.

The mercury should be cleaned in the apparatus shown in Figure 2. A is a small funnel with a filter paper folded as usual and which has a pin hole in its apex. B is a separatory funnel which contains concentrated sulphuric acid and mercury sulphate. In passing through this bath, any contaminating substances are removed from the mercury.

A thermometer hung on the hook, Y, serves the double purpose of a plummet and a temperature indicator. The tube must be absolutely vertical in order to insure accurate readings. The meniscus in this barometer is distinctly characteristic and readings should be made at the point of greatest convexity. If the cistern be slightly lowered and then raised to the proper adjustment before each reading, a meniscus of constant form will result, hence obviating any possible error due to a change in its shape. An image of the scale can be seen in the lower side of the bent arm. This aids greatly in making the readings.

When filling the tube with mercury, remove the air bubbles with a piece of flexible iron wire, add mercury until completely full and press a cork cap, Figure 3, over its top, taking care to exclude all air. Then place the empty cistern over the tube and cap and, pressing cap and tube firmly against the bottom of the bottle, invert all. Pour mercury into the cistern and raise the tube carefully. The downward pressure of the mercury should force the cap from the tube. If this is not sufficient, a slight pressure with a pencil or glass rod will remove it. Having turned the hooks on the support, place the tube and cistern in position,

then fasten by turning the hooks back into place. Cotton wool should be loosely placed in the neck of the bottle to keep out the dust.

The satisfaction derived from this instrument will compensate amply for the small amount of time and trouble required for its construction. It will prove as accurate and efficient in action as many comparatively high priced barometers.

CHANGES OF LENGTH AND HYSTERESIS LOSSES ACCOMPANYING MAGNETIZATION.

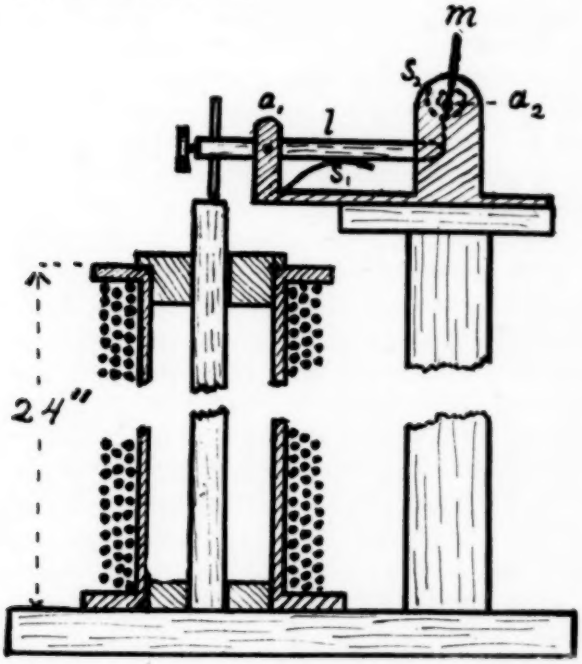
By E. P. Lewis,

University of California, Berkeley.

An interesting lecture experiment showing the changes of length accompanying magnetization and the heating effect due to hysteresis has been shown in this university for a number of years. The writer has not seen any published account of a similar lecture experiment, therefore it may be worth while to describe it. A solenoid of about 1000 turns of No. 16 wire is wound in three layers on a brass tube about two feet long and one inch in diameter, mounted vertically on a solid wooden base. Within each end of the tube is placed a brass collar with a central opening about 8 mm. in diameter, into which may be placed a closely-fitting rod of iron or steel somewhat longer than the solenoid. On the top of a stout wooden standard parallel to the solenoid is screwed a magnifying optical lever devised by G. P. Kraus, assistant mechanician, all the parts of which except the springs are made of brass. The small rod r may be adjusted so that its end is held firmly against the top of the iron rod by the spring s. Any change in length in the rod causes a rotation of the lever l about the axis a_1. The other and longer end of the lever is attached to a stout thread which is wrapped around the axis a_2 and kept under tension by the spring s_2. The axis a_2 is about 1 mm. in diameter. A displacement of the lever causes a corresponding rotation of this axis and an angular rotation of the mirror m attached to it. The arms of the lever are respectively 8 and 32 mm. long. A change of length x in the rod causes a linear displacement of $4x$ at the long end of the lever. The resulting angular rotation of the axis and of the mirror is $4x/r$, where r is the radius of a_2. A beam of light reflected from the mirror is subject to twice this angular displacement. If the beam of light is thrown on a screen at a distance L the spot of light moves a

distance equal to $8Lx/r$. If L is 700 cm. this distance is $112{,}000x$. Thus a magnification of more than 100,000 is readily obtained.

When a current is sent through the solenoid the rod elongates, as shown by the motion of the spot of light. As the current is increased, the rate of elongation becomes less, and finally is followed by contraction, so that the rod may become shorter than it was in the beginning. Soft iron and hard steel differ greatly in the amount of elongation and in the critical value of the field which will produce shortening.



This effect was first studied by Joule[1] and later by Bidwell[2] and others. It appears that in most cases there is little or no change in volume, the cross section becoming less as the length becomes greater. If an alternating current is sent through the solenoid, the changes in length are synchronous with the alternations of the current and a musical tone of corresponding pitch is heard. This explains the "singing" of the core of an electromagnet when an alternating current is sent through the coil.

A part of the contraction may be due to the action of the field of the solenoid on the induced poles in the iron, but the greater part of this effect and all the elongation must be due to

[1] Phil. Mag., 1847.
[2] Proc. R. S. 40, 1886.

internal changes in molecular arrangement accompanying magnetic induction. It may be imagined that the first effect is that the molecules orient themselves parallel to the field and crowd into line, thus causing an increase in length; then an increase in the field will crowd them more closely together, causing contraction.

If the exciting current is rapidly interrupted, the core is magnetized and demagnetized many times in succession, and the internal resistance of a frictional character results in the development of heat (hysteresis loss) corresponding in amount to the internal work done in overcoming the coercive force of the magnetic material. If an alternating current is used, the magnetism is completely reversed at each alternation, and the effect is much greater. If the iron is very soft only a small amount of heat is produced; if hard steel of great coercive force is used a large amount of heat is developed. The change of temperature causes the spot of light to move rapidly and steadily across the screen. It is interesting to note the difference in the rate of movement when soft iron is compared with tempered steel.

Some change of temperature might be expected from the heating of the solenoid by the current and from eddy currents in the brass and iron. This very slightly affects the result, however, for if a rod of brass or copper is substituted for the iron the steadiness of the spot of light shows that the heating effect is very small. With the brass or copper core no "singing" will be heard.

Since the coefficient of expansion and the specific heat of the iron are known, probably very accurate measurement of the hysteresis loss of energy might be made by this method. The heating is uniform throughout the rod, and observations might be made so quickly that there would be little loss by radiation or conduction.

Bidwell likewise used an optical lever, but the design was different and it was not nearly so sensitive as that here described. The maximum elongation observed by Bidwell was about one part in one hundred thousand.

President Harry Pratt Judson, of the University of Chicago, announced in his recent Convocation statement that Associate Professor Charles Riborg Mann, of the Department of Physics, has been given leave of absence for a year from April 1st, to carry on an investigation under the direction of the Carnegie Foundation for the Advancement of Teaching. Professor Mann is a graduate of Columbia University and received his degree of Doctor of Philosophy from the University of Berlin.

SOME EXPERIMENTS IN THE TEACHING OF SEX HYGIENE IN A CITY HIGH SCHOOL.

By Charles W. Fender,
Lowell High School, San Francisco, California.

A great deal is being said at present regarding the teaching of matters pertaining to sex and reproduction in the public schools. Most students of the subject believe that the prevailing ignorance on these matters among people in general is one of the causes of existing social conditions in matters pertaining to sex relations. The general public is not quite ready to agree that we are going to improve the present state of affairs by teaching men and women, and especially boys and girls, the important facts regarding human sex and reproduction, popularly known as sex hygiene. One hardly needs to argue this point with scientists; the debate is as to how and where such instruction should be given. There is pretty general agreement that the best place is the home, but many fathers and mothers are not capable of teaching their sons and daughters the things they ought to know, and most refrain from it. Can the subject be taught in the schools? The general answer at present is that it can not. And the chief reason is that we have not teachers who are able to handle the subject. However, I believe that under proper conditions such work may be safely taken up in the high schools at least. In Lowell High School as in every other city high school there is abundant evidence of the need of instruction. As a teacher of biology I felt that it devolved upon me to undertake the problem. In this paper I propose to give some of the methods I have used and the results I have obtained.

Zoölogy is taught in the second year of the high school course. The student may elect either zoölogy or botany. A year is devoted to each and the work may begin either semester.

There are about one thousand students enrolled in the school. From one hundred forty to one hundred sixty are enrolled in zoölogy, and of these approximately three-fourths are boys. No attempt is made to divide the boys and girls the first semester, but this division is made at the beginning of the second semester. At present there are two sections of boys and one of girls taking the second semester's work. There are twenty-four boys in each of the sections, and eighteen girls in the third. No attempt has been made to teach sex hygiene to the girls.

I believe that such work should not be taken up as a separate

course but should come near the end of a course in biology. It should not be given by special lecturers but by the regular biology teacher. Hence the impracticability of teaching it to my girls at present. The foundations should be carefully made, and instruction in sex hygiene should follow antecedent work in a natural manner. It seems necessary at this point to give a brief review of my course, emphasizing only the parts which more directly provide a basis for sex-instruction.

The work of the first semester is begun with a study of insects. Here questions of reproduction, life history, periodicity, etc., may be taken up and illustrated. In the succeeding work on the protozoa the pupil studies and comes to know a single cell. He learns about such forms of reproduction as fission, spore formation, and conjugation. The coelenterates illustrate another form of a sexual reproduction quite clearly, namely budding. They also reproduce sexually, and in certain cases the same individual bears both eggs and spermatozoa. So on through the other invertebrate groups a study may be made of sexual forms of reproduction.

Coming now to the vertebrates, the fish and frog are of course stock examples for teaching the subjects of egg-laying, fertilization, and development. In connection with the birds, the structure of the reproductive system and the formation and fertilization of the egg may be studied in considerable detail. In the study of mammals their distinguishing characteristics in matters of reproduction should be pointed out. Man is a mammal, and questions relative to human reproduction may logically be taken up here.

The boy should know the structure of his own reproductive system, and the general function of the different parts, and especially their hygiene. He should be taught some of the important facts regarding the female system. The meaning of puberty, and the changes undergone at this period, should be explained. He must be taught the importance of keeping himself clean. He should know some of the facts regarding venereal diseases, especially the methods of contagion. Great stress should be laid on points of general hygiene, for if the boy is taught how to live properly a great deal of the necessity of sex-instruction will be avoided.

The results I have obtained have been very gratifying. At the end of the work last semester I wrote the following questions on the board:

1. Do you think this work has been beneficial?
2. Are you glad or sorry that you have had this course?
3. Will it tend to make you more cautious, or has it aroused your curiosity and made it harder to control your sex life?
4. Do your parents approve of the work?

The boys were urged to tell the truth without any thought as to what they wrote pleasing me. Each boy gave a strong affirmative answer to the first two questions. They were practically unanimous in their statements that they had never received any instruction of the kind, and that they had been very curious about the whole question. There was every indication that they wanted the knowledge for the good it might do them, and I could detect no evidence of any kind of morbid interest in the subject. Several stated that their curiosity had been allayed, that their minds had been settled, and that the information they had received had made it much easier for them to control their passions. Some indicated a desire to do missionary work, in teaching other boys the things they ought to know. Some held up the positive side and said that it had taught them the value of leading clean lives, and to respect womanhood and motherhood. One boy said, "At first it naturally aroused my feelings, but on seeing the matter correctly no room was left in my mind for wrong thoughts." Several expressed a regret that they had not been taught earlier, indicating that they were already engaged in wrong practices. This is an evidence that some instruction should be given the boy before he reaches the high school. Some stated that my teaching had had the effect of eliminating the foul talk that had been going on among that group of boys and their associates. They indicated that they had talked the subject over quite freely with their parents and that they heartily approved of the course and were glad that such work had at last been started. I may say here that I have never had any objection made to my work either by parents or school authorities.

Some general results may be noted. I have never felt that I have had the confidence of any group of students as those boys with whom I have taken up this work. Individual boys have come to me to talk certain things over in a free manner. They have shown a desire to coöperate with me in doing anything to raise the general moral standards of the boys of the entire school. Certain instances have arisen that have shown the perverted ways of some boys in the school and I urged my students that at least they could and should discountenance such things. I believe that

the general effect upon the school is going to be to create a much better atmosphere. I was pleased a few days ago to have a chap six feet tall, and one, by the way, from whom I could never get any good until I had taken up this sex hygiene work, come all aglow with joy and tell me that they were going to have a new baby in their home soon, and then in a few days come with great gusto and announce the arrival of a little sister. This case I regard as something unique. It is not what one would expect from a real boy.

Realizing that I could get the best results in my work by having the sympathy and coöperation of the parents of my students I set myself to this task. Also I wished to do my part in helping on the good work of educating parents to teach their children themselves. In the first place private conferences were held with a number of parents. I found that each one knew about the work I was doing, was heartily in sympathy with it, and willing to cooperate in any way possible. I had several talks with mothers. One is so characteristic in that it illustrates the attitude of mind of a great number of parents that I desire to relate it. She said her daughter was all she had and that she wanted to keep her innocent, that it was such a beautiful thing to see her innocence and purity that she couldn't bear to tell her anything pertaining to her sexual life. I tried to point out that the daughter's apparent innocence might prove ruinous ignorance, and stated that she could not always keep her daughter under her thumb. I had on my desk Dr. W. S. Hall's books, "The Doctor's Daughter," and "Life Problems." I said to the mother, "Take these home and read them, and if you believe they are a good thing for your daughter to read, have her do so before you return them." She was very glad to take the books. In a few days the daughter returned them and said her mother liked them very much. I said, "Did you read them?" She answered, "No, mother prefers to teach me step by step." The girl was then about fifteen years old and had not received the first step.

After talking with as many parents as I was able to interview, I sent letters to the parents of all my students and of the boys to whom I had given the work last semester asking them to meet with me for a conference on the evening of February 19, 1914, at the high school building. I pointed out in the letter that I needed their coöperation in the work I was doing. About fifty responded to the invitation and we had a most interesting meeting. I explained my course as a whole and just how I took up

the work in sex hygiene. Emphasis was laid upon the need of such teaching in the home and the benefits of beginning it early. In concluding I asked for an expression from them. It reminded me of scenes in an old-fashioned revival meeting. Two or three were on the floor at once. They were loud in their praises of my work, and indicated a desire to do something with their children themselves. It seemed to me, however, that perhaps some of them were pleased at being able to shift the responsibility. One physician related his experiences as a medical man. He said he was the father of five children, three of whom had graduated from the school and two were still in it. He told the need of such instruction in strong and positive terms, and then hanging his head said, "I am ashamed to confess I have never said a word about it to my own children."

The proposal of arranging for a series of lectures for parents was brought up. They were enthusiastic in their approval. Three lectures were arranged for and programs were sent out. I should not neglect to state that I was very much assisted in this work by the secretary of the California Social Hygiene Society.

The first lecturer was Rabbi Martin A. Meyer, a prominent worker in the field. He spoke with great force upon the need of such instruction, and his lecture was well received. The second lecture was given by Mrs. C. S. S. Dutton, who has done considerable work with Professor Davenport at Cold Harbor. Mrs. Dutton, because of her biological training, was well qualified to speak on some of the methods of instruction. Dr. W. P. Lucas, Professor of Diseases of Children in the Medical College of the University of California, gave the third lecture. Although he dealt more particularly with the medical phase of the question his lecture was somewhat general, and he considered such questions as the need of instruction, the necessity of teaching the child early, the value of keeping the child's mind under control by providing the right kind of interests, etc. It was gratifying to have him say that girls need instruction as well as boys. After talking for a short time he urged that those present ask any questions in which they were specially interested. They responded quite freely and a general discussion ensued, which proved very interesting. One woman stated very emphatically the importance of always telling the child the truth. She said she had never found any necessity of resorting to stork stories in raising her children. Another made the statement that she agreed with most people that the proper place of instruction was the home, but since the majority

of parents were not qualified she believed the instruction should be given in the schools when the proper conditions existed.

At the first of the three meetings fifty-five were present, and at the second fifty. Before the third lecture I sent out extra cards of announcement, giving some particulars regarding the lecture. One hundred twenty-five parents came. This gives an average of seventy-three at each of the three lectures, which is very good indeed. In Oregon, which ranks first among the states in its work along the lines of social and sex hygiene, the average attendance at parents' meetings is from fifty to sixty, so Dr. Eliot, National Secretary for the Pacific Coast, tells me.

Some general conclusions may be stated.

1. The interest in matters of social and sex hygiene is gradually growing. More parents are coming to believe in giving boys and girls the proper instruction.

2. One working with high school students has abundant evidence of the need of such instruction.

3. One of the most important reasons for providing courses in nature study and biology is to establish a normal, natural basis for the understanding of problems of sex and reproduction in man. Boys and girls must have the right attitude before they can be taught sex hygiene.

4. Sex hygiene can be successfully taught in the high school. It should come near the end of a course in biology. In a number of cases the work has been given by special lecturers, in most cases physicians. Physicians too often deal almost entirely with the pathological aspects, and very little of this should be presented to boys and girls.

5. A teacher of this subject should always endeavor to get the coöperation of parents, and parents' meetings should be made an important phase of the work.

ARITHMETIC ADOPTIONS.

The Modern Arithmetic Series for the grades has been adopted by the states of Tennessee, Kentucky, and Oklahoma. These books are published by Lyons & Carnahan. The authors are Henry C. Cox, A. M., District Supt. Public Schools, Chicago; Geo. A. Tallant, A. B., and Frederick H. Umholtz. Ph. M. In view of the fact that the series has been completed less than half a year, this is quite a record—perhaps never before equalled by any arithmetics.

WHAT IS AN AREA?

By A. B. Frizell,
McPherson College, McPherson, Kans.

Aristotle asserted that the geometer and the carpenter study the straight line differently, the one inquiring how he can use it in his trade, the other asking what it is.

Today, however, with a civilization founded on geometry and geometry laying its foundations deeper and deeper in arithmetic, it is time to get rid of the Aristotlian autithesis.

It is maintained in the preface of a recent admirable textbook that "students are interested in the study of mathematics only in so far as they are able to think their way through the work." Yet the same book lays down the definition: "The measure of the area of a surface is the number which expresses the magnitude of its area in terms of the adopted unit of surface."

To test this definition, let us construct a rectangle $OMPN$ (see Figure 2) having the sides OM, ON respectively 2 and 6 linear units, and then change the shape of the rectangle so that its area shall remain the same, by moving the vertex P continuously to a point Q whose distances from ON, OM are 6 and 2 respectively.

How do we know that there is any measure of the area $MPQD$? Some one will answer, of course, that it can be found by integration. That is to say, we have no definition of the measure of $MPQD$ without calling in calculus.

FIGURE 1.

The definition in question is nevertheless regarded as satisfactory for rectilinear figures, since any polygon can be divided into triangles. Construct a right triangle with a base 4 and an altitude of 3 linear units. Everyone will say that the measure of

its area is 6; but what does this mean? Certainly not that the triangle is composed of six unit squares, because anyone can see that it contains only three. The other three, then, are to be made up of fractional parts of unit squares, and, in fact, by dividing the linear unit successively into 2, 4, 8 equal parts, we readily find six squares each one-fourth of the unit, then 12 sixteenths and 24 sixty-fourths, making total of 18 fourths, 84 sixteenths and 360 sixty-fourths, respectively. But this process can never exhaust the area of the triangle, and we are again confronted with the problem of integration—to find the limit of a certain sum when the number of its terms is indefinitely increased.

Here it will be objected that this reasoning is wide of the mark, that the area of a triangle is half that of a parallelogram and that of the parallelogram is equal to that of a rectangle having the same base and altitude. This is *eo ipso* an admission that the measures of the areas of a parallelogram and of a triangle were not defined, since it amounts to interjecting two supplementary definitions. Then it will be further necessary to say that by the measure of the area of a polygon we mean the sum of the measures of the triangles into which the diagonals from the same vertex divide it. But even a pentagon can be divided in this way into five different sets of three triangles each and there is nothing to show that the corresponding five measures agree.

The scope of the definition being thus narrowed down to rectangles, let us, for a final test, construct a square on a side of units in length and then a rectangle, R, of unit altitude on the diagonal of this square as a base. The rectangle, R, is measured by aid of the proposition that the areas of two rectangles with equal altitudes are proportional to their bases and the proof of the incommensurable case of this proposition is usually carried on by constructing, for a series of values of n, the greatest rectangle, V, of unit altitude, within R, whose base is a multiple of one nth of the linear unit. Then it is necessary to say that V approaches R as a limit when n is indefinitely increased, that is, that the difference between V and R approaches zero. But this difference, being a rectangle with an incommensurable base, can only be measured by aid of the proposition which we are trying to prove!

Such are the methods by which our future geometers are taught to study the rectangle. On the other hand, consider the processes of the paperer and carpet layer. They lay down no definition of the measure of an incommensurable magnitude, but content them-

selves with cutting off a commensurable strip long enough to cover a strip of the wall or floor *and lap over,* without stopping to ask whether the "exact" length is $9\sqrt{2}$ or $\pi^2\sqrt[3]{e}$.

Now the combination of the paper hanger's process with the method used above for the triangle furnishes the essential elements of the most rigorous mathematical analysis. To develop this idea, it is sufficient to follow the procedure of the engineer, for example, in estimating a drainage area from the map. Count the unit squares contained in the given figure. This number is the first approximation by defect. Count the unit squares in the smallest figure made up of such squares but overlapping the given boundary. This number is the first approximation by excess. The difference between these numbers is the first approximate error. Subdividing the linear unit, we shall have a second approximation. Dividing these subdivisions will give a third approximation, and so on. An approximation carried on in this way is called a *regular* process of approximation. The first steps for the problem of the triangle are tabulated (compare Figure 1).

Approximation.	Defect.	Excess.	Error.
First	3	9	6
Second	4.5	7.5	3
Third	5.25	6.75	1.5
Fourth	5.625	6.375	0.75

For a rectangle, the nth approximation by defect is the product $\frac{a_n}{q_n} \cdot \frac{b_n}{q_n}$ of the nth approximations by defect to the length of the base and altitude. The nth approximation by excess is $\frac{a_n+1}{q_n} \cdot \frac{b_n+1}{q_n}$ i. e., the product of the nth approximations by excess to the same lengths. The nth approximate error is $\frac{a_n+b_n+1}{q_n^2} < \frac{(a_n+1)+(b_n+1)}{q_n^2}$.

The approximation by defect always increases and that by defect decreases when n is increased sufficiently.

In any other process it is always possible to determine m so that the two mth approximations in it lie between those of the regular series belonging to any previously assigned n.

Thus the approximate area of a rectangle is the product of the approximate lengths of its sides.

This is the only meaning which the textbook proposition admits for the purposes of practical computation, and the facts comprehended in it form the only basis for a definition satisfying the

requirements of modern mathematics, or of instruction in physics or engineering.

To illustrate, let us apply the approximate process of the problem proposed at the beginning of this paper. Obviously it is not essential that the elements of the first approximation be squares, and here it is convenient to take rectangles of unit base having their upper right or left hand corners lying on the curve. Thus the first approximation by excess is $6+4+3+{}^{12}\!/_{5} = 15.4$ and the first approximation by defect is $4+3+{}^{12}\!/_{5}+2 = 11.4$. Bisecting the bases of the elementary rectangles we have for the second approximation by excess $3+2.4+2+{}^{12}\!/_{7}+{}^{3}\!/_{2}+{}^{4}\!/_{3}+{}^{6}\!/_{5}+{}^{12}\!/_{11} = 14.238\ldots$ and for the second approximation by defect $2.4+2+{}^{12}\!/_{7}+{}^{3}\!/_{2}+{}^{4}\!/_{3}+{}^{6}\!/_{5}+{}^{12}\!/_{11}+1 = 12.238\ldots$

It will be observed that in each case the approximations by excess and defect have all their terms but one common, so that the first approximate error is $6-2 = 4$ while the second approximate error is $3-1 = 2$.

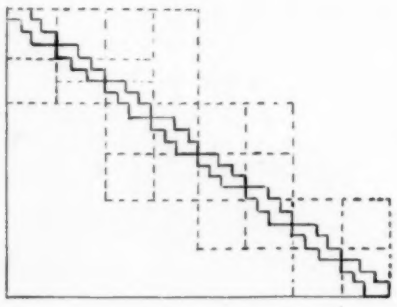


FIGURE 2.

It is easy to prove that the nth approximate error is the difference between the areas of the first and last elementary rectangles of the whole nth set. The altitudes of these rectangles are 6 and 2, respectively, while their bases are each $q_n = \frac{1}{2^{n-1}}$, so that the nth approximate error is $\frac{4}{2^{n-1}} = \frac{1}{2^{n-3}}$.

If a categorical definition be demanded, we can take a hint from Aristotle's definition of virtue as the mean between excess and defect and say that the area $MPQD$ is the number which lies between its approximations by defect and its approximations by excess.

FLATLAND—A MATHEMATICS PLAY.

A recent number of the *Mathematical Gazette* contains the following interesting report of a dramatic performance by the pupils of the Haberdashers' Aske's Girls' School, based on Dr. Abbott's *Flatland*. (*Flatland*. E. A. Abbott. 75 cents. Little, Brown & Co., Boston. Two other books on the fourth dimension are worthy of mention here. *The Fourth Dimension*. A collection of essays selected from those submitted in the *Scientific American's* prize contest. $1.50. Munn & Co., New York. *The Fourth Dimension*. Hinton. 4s. 6d. Swan Sonnenschein & Co., London.)

"The entertainment took place in the School Hall, the audience being seated in the gallery, thus looking down on the performers. In the first place, one of the pupils gave a short description of Flatland, explaining the following points: The audience were to imagine that they were looking down on an infinite plane, the inhabitants of which were aware of only two dimensions. An enormous pentagon, with gaps in its sides, drawn on the floor, represented a building. Flatlanders being unable to move out of their own plane, required nothing more than lines for walls, height having no meaning for them; the gaps in its sides were the doorways. These inhabitants were shaped like geometrical figures, and their social position was determined by the number of their sides. Thus, the many-sided figures constituted the nobility, whilst the artisans were triangles. Also, the more nearly a figure approached the regular shape, the higher the standing; thus an equilateral triangle was considered above an isosceles triangle, a square above a parallelogram, while the circle was the highest of all. By means of careful education the son of a quadrilateral, say, might in time become a pentagon, or even in some cases a son might be born possessing more sides than his father. The women, however, of all grades were merely straight lines, and so were invisible, when viewed from before or behind; in consequence they might cause considerable damage by running into those coming in the opposite direction, and, to avoid this, they were compelled by law to make a continual humming sound whenever they were in public places, so that they could be heard even though they might not be seen. As a further protection, women had to enter and leave all buildings by special doors.

In Scene I the inhabitants of Flatland were introduced to the audience by the narrator. They were represented by cardboard

models of circles, pentagons, and so on, carried horizontally on the girls' heads, thus showing the flat surfaces to the spectators seated in the gallery above.

The following characters marched around the hall and were introduced by name:

DRAMATIS PERSONAE.

The Priest's Family.

Nine Points Circle—*Priest.*
Asymptote—*Wife.*
Radial—*His son.*

The Nobleman's Family.

My Lord Manysides.
Perpendicular—*Wife.*
Aequalis and Planus—*Sons.*
Directrix and Tangenta—*Daughters.*

The Merchant's Family.

Mr. Protractor.
Bisecta—*Wife.*
Absurdus, Given and Cyclus—*Sons.*
Alterna and Corresponda—*Twin daughters.*

The Artisan's Family.

Mr. Acutus.
Similar—*Wife.*
Policeman X and Scalene—*Sons.*
Axis and Diameter—*Daughters.*

Other Characters.

His Reverence, the Circumcircle—*Priest.*
Sir Multilatus—*Nobleman.*
Mr. Ratio—*Schoolmaster.*
Mr. Rectangulus—*A heretic.*
Mr. Slantsides.
Base and Altitude—*His daughters.*

SCENE II.—AT PLAY.

Here the children "dance" and play "patterns," that is, they arrange themselves so as to form the well-known figures of geometrical propositions. These games would appear very dull and uninteresting to our children, who by virtue of their third dimension are enabled to play so many games with a sphere!

In the course of this scene one child relates a queer dream he had in which he visited a world of one dimension. Here all the

inhabitants were lines and moved in lines. They could walk backwards and forwards along their own lines without turning, but could never pass each other; their only means of communication, except with their immediate neighbors, was by shouting. The dreamer relates that these one-dimensional beings could not see him, although he was close beside them, but they could hear him. He says he insulted their king to whom he talked, by taking him for a woman, seeing that he was only a line. These creatures were much incensed at the folly of the idea of there being a "right" or "left"—"before" and "behind" they could understand, but "right" and "left" had no meaning for them.

Scene III. opens with the master awaiting the arrival of his pupils in the schoolroom. When these arrive they wish their master good morning, and greet him with a shake of the head—a bow or courtesy being, of course, impossible to a Flatlander. Lessons begin; the essential thing for a child of Flatland to learn is to recognize the size of angles by touch, so that he may leave school well equipped for later life. For, when two Flatlanders meet, they feel each other's angles, and thus recognize the grade of the person they have met; a mistake in this might lead to a great social trouble. Considerable time, therefore, is given to this subject in the school curriculum, and some of the children become very clever at it, being able to tell an angle within a degree by merely feeling it.

The next subject for the day is so-called algebra—in this they say their tables and then go on to squares, cubes, and symbols. Then follows a lesson on dimensions. The schoolmaster shows with models that a line is formed by the movement of a point, and an area by the movement of a line. One of the pupils, evidently a thinker, besides being the dreamer of Scene II., tries to connect this lesson with the last, and says: "If you can both square and cube x, why should you not be able to get another figure beyond a square when you multiply the length of a line by itself again? And what does an area form when it is moved?" The schoolmaster thinks that these are foolish questions, and shows that an area cannot be moved so as to generate anything else than an area. Just then a voice is hear to say "Move it up." The Flatland characters cannot see who is talking, for the voice proceeds from a sphere which is above the Flatland plane, and therefore invisible to them. The master ponders over this so deeply that he does not realize that all his pupils have run away, and the scene closes with the schoolmaster trying, in a very

puzzled way, to find out what is moving his model "up," a word hitherto unknown to Flatlanders.

In Scene IV. Lord Manysides and Sir Multilatus meet in the street and recognize each other in the way indicated in the previous scene. While talking, they encounter Mr. Protractor, who, though only a merchant, is intelligent beyond his sides, and has become a friend of Sir Multilatus. He introduces Mr. Protractor to Lord Manysides, the method of introduction being peculiar; first, Lord Manysides feels all Mr. Protractor's sides and angles, so that he will be able to recognize him by touch when next they meet, and then the operation is repeated by Mr. Protractor. After some conversation, Lord Manysides invites Mr. Protractor and his wife to dinner.

SCENE V.—HOUSE OF LORD MANYSIDES.

Lord Manysides, on returning from his walk, tells his wife that he has asked Mr. and Mrs. Protractor to dinner. She is so angry at his having asked a mere merchant and his wife to dinner that she runs at her husband as hard as she can, and kills him by piercing his polygon with her rod. She is overcome by grief and remorse, and makes no resistance when Policeman X comes to arrest her.

SCENE VI.—IN THE PRISON.

There are several prisoners present when Lady Manysides is brought into the prison, and these are discussing the various causes for their imprisonment. One says that he is there for fraud —being an isosceles triangle, he applied for a post open only to a rhombus, and obtained it because he and his son walked with their bases in contact.

Another is our old friend, the dreamer, who is charged with heresy because he would persist in discussing the possibility of a third dimension.

SCENE VII.—IN THE LAW COURT.

The trial of the heretic is proceeding, and everybody is pointing out the absurdity of the idea that there could be a third dimension, when a new witness suddenly appears, entering where there is no door, much to the surprise of everybody in court. However, he looks like a circle, so all make way for him, supposing him to be of the nobility; but they notice this peculiarity about him, that his size is continually changing, and sometimes he disappears altogether. The fact is that he is a sphere, and he thinks to convince them of the third dimension by bobbing up and down, and by

jumping over their line wall. But this point is quite lost on the Flatlanders, who cannot conceive such an idea. He tries hard to explain himself to those present, and lets them feel him all over, but they are quite mystified, except the dreamer, who at last sees some glimmer of light on his doubts.

The court breaks up; the prisoner is released and goes away with the sphere to learn more of this strange phenomenon.

ANOTHER CLEAN RECORD IN THE CANAL ZONE.

The report of the department of sanitation of the Isthmian Canal Commission for September, 1913, showed that during that month not a single white man, woman or child from the United States had died from disease on the Canal Zone. The report for February, 1914, shows that another record has been established. During that month there were 7,592 white employes. Among this number, equal to the population of a good-sized city, there was not a single death from disease during the month. Two white employes were killed by accident, one by electric shock and the other by injury received on the railroad, but no white employe, either American or foreign, died from disease during that time. As might be expected, the death-rate among other classes was equally low. Of the 5,309 white employes from the United States, there was only a single death by violence. Of the 3,875 white women and children from the United States, there was one death from accidental drowning and three from disease. One, a child of 4 years, died of diarrhea; another, a woman of 70, died of old age, and a third, a woman of 44, died of pulmonary tuberculosis. Out of a total of 9,184 white American employes and their families, there were only three deaths from disease and two from violence, while among the total 10,963 Americans on the Canal Zone, there was only a single additional death from violence, making a total of six deaths for the month among nearly eleven thousand persons, equal to an annual average death-rate of 6.56 per thousand. Nor are the benefits of improved sanitary conditions limited to white employes and their families. In February, 1914, there were 41,867 colored employes, and among this number there were only twenty-two deaths from disease and six deaths from violence, making an average death-rate per thousand from disease of 6.31, equivalent to a total annual average death-rate, for the entire 49,459 employes, of 5.34 per thousand. Of the twenty-one deaths, four were from pneumonia, seven from tuberculosis and one each from organic disease of the heart and typhoid fever, leaving nine deaths from all other diseases. After living for five or six years amid conditions which have produced such a startling reduction in the death-rate, will the men who have dug the Panama Canal be able to find any city in the United States which is sufficiently cleanly and healthy for them to live in? Let us hope, says *The Journal of the American Medical Association,* that the ten thousand Americans, returning to this country after a practical demonstration of what modern scientific knowledge can do to prevent disease, may prove to be the little leaven which will leaven the entire lump. If this is the case, the indirect benefits of the Panama Canal will be incomparably greater than its commercial or military value.

PREPARATION OF MICROSCOPIC MATERIAL FOR A COURSE IN GENERAL ZOÖLOGY.

By Tracy I. Storer,

Department of Zoölogy, University of California.

During the summer vacation of 1913 it became necessary to prepare an extensive series of slides to supplement those already on hand for use in the course in general zoölogy at the University of California. As the work progressed it became evident that there were a number of points in the technique employed hitherto not reported in the literature. When the work of writing these up was commenced it was deemed advisable to expand the notes so as to include directions for preparing all of the types used.

The work was carried out under the direction of Professor C. A. Kofoid of the Department of Zoölogy to whom I am indebted for criticism of the paper as presented. The technique for preparing cestode material was worked out by Mr. Albert L. Barrows and that for the earthworms by Merrill W. Hollingsworth, George E. Stone and myself. Miss Olive Swezy and Miss Violet Bathgate assisted in preparing the material.

Apparatus.

A paraffine oven and a Minot rotary microtome were available together with the usual supply of laboratory glassware and chemicals. Grubler's stains were used throughout the work. For staining serial sections the staining frames manufactured by F. Hellige and Company, Freiburg im Breisgau, were used.

Staining in Toto.

For small material such as *Hydra, Gonothyrea, Planaria* and 10 mm. *Amphioxus* the following piece of apparatus was devised (see Figure 1). A glass vial about 20x60 mm. with constricted neck was cut off about 5 mm. from the base. This was accomplished by making a file scratch where the cut was to be made, and then wrapping a strip of moist blotting paper around the vial at each side of the scratch. The narrow exposed area was then rotated in a pointed flame and with a little care an even cut was usually made, the edges of the cut surface being smoothed with a file. Next a small piece of bolting silk of small mesh (1 mm. or less) was tied over the mouth of the vial by a thread around the constricted neck. The vial was then inverted and the material to be stained placed in it.

The series of stains and alcohols, etc., through which the material passed was placed in Harvard Staining Jars (of the Kny-Scheerer Company) or in small stender dishes. These vials provide a ready means for handling delicate material for whole

FIGURE 1.

mounts or for running material which is to be imbedded and sectioned up through the alcohols and into the clearing agent. They have the advantage over Steindach's staining dish in being easier drained, possessing smaller holes and having less diameter making it possible to use them in smaller staining jars. Whenever very delicate material such as *Hydra* is ready for mounting it is advisable to cut the thread holding the bolting silk in place and drop both silk and specimens into a small open stender dish containing balsam. The specimens can then be picked up in a pipette with little breakage.

ORIENTATION OF SECTIONS.

It is a simple matter when cutting and mounting sections to orient the material so that the resulting mounts when viewed through the microscope will have what might be termed a normal position, i. e., dorsal side away from the observer in cross sections, anterior end of the left and dorsal side away or anterior end away and dorsal surface to the right in parasagittal sections, and anterior end away in frontal sections. The following rules provide for such orientation:

Cross Sections.

With microtome at the operator's right and knife toward the left the anterior end of the specimen should be toward the knife, the right side uppermost and the dorsal surface toward the operator.

Parasagittal Sections.

When sections are to be placed parallel to the shorter side of the slide, ventral side uppermost, left side toward knife and anterior end toward operator; when sections are to be placed parallel to the longer side of the slide, dorsal side uppermost, left side toward knife, and posterior end toward operator.

Frontal Sections.

Left side uppermost, dorsal side toward knife and anterior end toward operator.

ORIENTATION OF WHOLE MOUNTS.

Specimens 18 mm. or less in length can be mounted with the

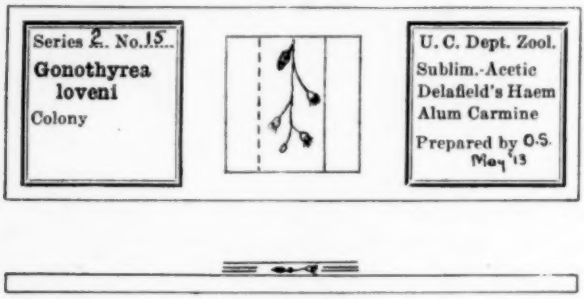


FIGURE 2.

distal end (as in *Gonothyrea*) or anterior end (as in *Planaria*) toward the operator (see Figure 2). Larger specimens should be mounted with the dorsal side toward the operator and the anterior end to the right (Figure 3). As the image is rotated 180° in the plane of the object, specimens oriented as directed will be in convenient positions for study or drawing.

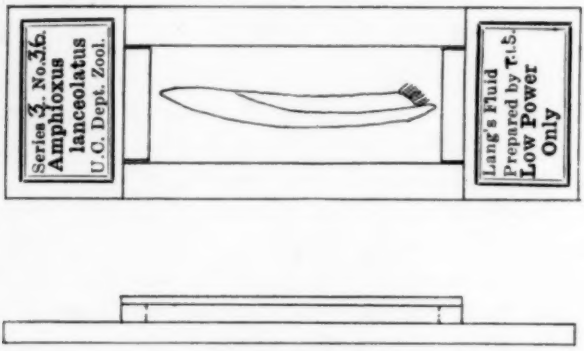


FIGURE 3.

LABELING.

The summer's work resulted in something over 2,000 slides being prepared. The labeling of these slides by hand would have been an enormous task and to have them printed in a regular office would have been prohibitive because of the cost. A small printing press and accessories were therefore purchased. Brass rule was cut and beveled to form hollow squares 4½ ems (printer's

measure) outside. Some pieces 2½ ems long were provided for the narrower labels. Pieces of 1, 2, and 6 point "leads" were used to fill out the brass squares. Linotype slugs bearing lines such as shown on the labels in Figures 2 and 3 were provided for printing the data.

For labeling non-curling gum paper cut 1⅞ inches was used. The narrow margins on the labels when printed made it impossible to use gauges in the press in the ordinary way so the labels were printed two at a time on the upper half of the sheet as it was placed in the press, then reversed, printed on the other half and cut apart.

The labels were placed on the slides as shown in the accompanying figures (2 and 3). Giving each slide a series and individual number made it possible to locate or replace any individual slide while the initials of the preparateur and date of preparation give a clue to its history.

Protection of Specimens from Crushing.

To prevent crushing of whole mounts under small cover glasses (18 or 22 mm.) two strips of No. 2 cover glass were placed under each side of the cover (see Figure 2). This has an added advantage in reducing the amount of balsam under the cover glass and consequently shortens the length of time required before the slide can be used.

For the larger specimens of *Amphioxus* (40-50 mm.) the following plan was used. From thick slides two strips, 3x14 mm., and two, 5x46-56 mm. (length depending upon specimen to be accommodated, see Figure 3), were cut. The two long strips were "tacked" to the slide with thick balsam and one end strip was put in place. The specimen was placed in the hollow thus formed and the space around it filled with thick balsam. Then a thin slide cut to the proper length (46-56 mm.) was lowered over the top from the closed toward the open end and the remaining end strip was put in place. If all four of the supporting strips are put into place before the top piece it is practically impossible to prevent the formation of air bubbles under the cover slide.

One point that has not been emphasized sufficiently if at all in the literature of technique is that of placing material of any kind on the *convex* side of the slide leaving the concave side with its high corners to rest on the stage of the microscope. The direction of curvature can be determined by a glance along the long edge of the slide.

"LETTER" MOUNTS.

For demonstrating the use of the microscope in determining the vertical relations of parts mounts arranged as shown in Figure 4 were prepared. A number of small asymmetrical letters of the same kind were cut out and cleared in xylol. One was laid down on a slide, covered with a thin layer of balsam, an 18 mm. square

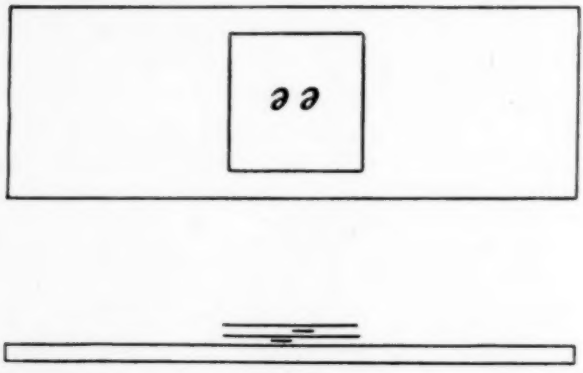


FIGURE 4.

cover glass placed over it, another letter laid down on the cover glass and at one side of the first letter, covered with balsam and a second cover glass laid over the first. All slides were made with the letters in the same relative positions so that class discussion can be carried on while the students are at their microscopes.

PORIFERA.

Spicules.

Alcoholic specimens of *Grantia ciliata* were boiled in weak sodium hydroxide solution until disintegrated. As much as possible of the organic material was removed by washing and decanting. The material was then treated in two different ways. Some was brought into 10% formalin, placed under circular cover glasses and the margins rimmed with Bell's cement. Many of these were later found to be imperfectly cemented as the formalin crystallized out. If the margins had been rimmed with balsam after the cement was applied this difficulty would have been avoided. By far the better method was found to be mounting in balsam. The material was dehydrated, brought into balsam and mounted under square covers. Besides doing away with the difficulty from evaporation this method makes the remaining organic material transparent and not noticeable when studying spicules.

Sections.

Material from Woods Hole Biological Supply Department, fixed and preserved in alcohol, was hardened, imbedded and cut into cross-sections 83 microns thick. The sections were separately mounted and stained individually in Gentian Violet in 95% alcohol and mounted under circular covers in balsam. Thick sections such as these show clearly the relations of the canal systems and of the different types of spicules while thinner sections as a rule do not.

COELENTERATA.

Hydra.

Leaves and debris from a nearby creek were placed in shallow glass dishes and covered with water. When the Hydra had gathered on the upper surfaces of the leaves they were collected by means of a pipette made of a large bore glass tube and atomizer bulb. They were placed individually in Syracuse dishes with small quantities of water. When the tentacles were well extended warm Schaudinn's Fluid was forced over them from the aboral toward the oral end. Usually this resulted in their being killed in an extended condition. Preservation was in 80% alcohol. The specimens were then placed in the gauze-bottomed vials previously described, run down through the alcohols to water, stained 5 to 10 minutes in Delafield's haematoxylin, run up through the alcohols, slightly decolorized to make the structures clear, dehydrated, cleared and mounted in balsam with protecting strips under the cover glass.

Colonial Hydroid.

Gonothyrea lovenii from the Naples Biological Station, fixed in sublimate-acetic with the tentacles well extended, and preserved in alcohol was used. The small colonies were clipped from the substratum (in this case a tunicate) stained in either Delafield's Haematoxylin or alum carmine and mounted in balsam with side supports. Care was taken to include a typical colony with feeding polyps and goangia on each slide.

PLATYHELMINTHES.

Planaria.

Animals collected from a nearby lake were used. The animals were flattened by pressure between two plates of ordinary window glass, the upper one being about 2 inches square. When well extended hot (40° C.) Zenker's Fluid was forced between the

plates successfully killing the animals in an extended condition in most cases. After killing they were left in the fluid about 15 minutes then washed and preserved in alcohol for a few days. Staining was with Delafield's Haematoxylin for 15 to 30 minutes and then, after slightly decolorizing, with Orange G for a few minutes. They were mounted in balsam with supported cover glasses. If the animals are kept in filtered creek water for a few days before killing the digestive tract becomes emptied and more clearly defined.

Cestodes.

Proglottids of *Taenia saginata* and *Dibothriocephalus latus* and complete specimens of *Dipylidium canis* were prepared. In killing a tape worm a streak of the fixing fluid was run along a strip of glass, the worm then grasped by the antiscolex end, the scolex lowered into one end of the streak of fluid and then the rest of the animal slowly lowered into place, care being taken to prevent any twists in the worm as so laid down. After fixation the worms were laid on strips of hard filter paper and rolled around glass cylinders for preservation in alcohol. Staining was done in alum carmine for 12 hours or longer. They were then dehydrated, cut into pieces of 2 or 3 proglottids each, cleared, infiltrated in balsam for several days and mounted. Glass tubing drawn out to a diameter of about 0.5 mm. was used for supporting the cover glasses. After the cover glasses were in place small square weights were placed over them to hold the mounts down. Mounts of this sort where there is a considerable amount of balsam need to be examined daily and supplied with additional balsam to compensate for the shrinkage due to evaporation of xylol. This may be necessary for two or three weeks. If a very thick balsam is used this trouble will be mitigated to some extent. Proglottids of *Taenia* and *Dibothriocephalus* were mounted under 22 mm. square cover glasses while the specimens of *Dipylidium* were cut into pieces of proper length and mounted under 24x40 or 24x50 mm. cover glasses. It was found advisable to put the scolex-bearing piece between two of the others rather than at the upper edge of the cover to give it better protection from crushing.

ANNELIDA.

Helodrilus caliginosus trapezoides, the commonest earthworm about Berkeley, was used. The preparation of these animals in serial sections is well known to be difficult. Worms were collected, separated from any adhering earth and alternately put

in water for one-half hour and in a dish without water for one hour for 24 hours or more. When the digestive tract had been entirely cleared they were placed in full strength carbonated "Shasta" water for 15 minutes or longer until stupefied. Then a number of glass tubes of sufficient bore and length to hold individual worms were provided and the worms placed in them. This was done by holding the worms by the posterior end under a stream of water and bringing the tube slowly up over the anterior end when the stream of water carried the worms into the tubes. Then the tubes were placed in a beaker deep enough to contain them, the beaker being placed on its side and the tubes laid in horizontally. The beaker and contents were erected and the fixative (Zenker's or Bouin's Fluids) poured in so as to come upon the animals from below. They were washed and brought up to 70% alcohol (Zenker's fixations being treated with iodine in alcohol to remove any mercury salts remaining). From this preservative the animals were brought into 95% alcohol for 2 hours, into absolute alcohol for 2 hours, in cedar oil for 15 to 18 hours (over night), saturated solution of paraffine in cedar oil 3 hours, melted paraffine (52° to 55°) 2 hours, the paraffine being changed at the end of the first hour and the imbedding being in fresh paraffine. All sections were cut 10 microns thick. These were mounted for 24x40 mm. cover glasses in the case of the parasagittal sections and for 22x22 mm. cover glasses in the case of cross sections. Sections were stained in strong Delafield's Haematoxylin for 5 to 20 minutes, decolorized in acid alcohol (70 % alcohol + 1 % HCl), being watched under the microscope until the proper condition was reached when the decolorization was stopped by immersion in 70% alcohol with $LiCO_3$ Erythrosin (5% of a saturated 95% alcoholic solution in 70% alcohol) was used as a counter stain. This stains very rapidly at first (less than a minute) but as the alkali used to neutralize the decolorizing acid is carried over, the period becomes lengthened to 10 minutes or more. Sections were mounted in balsam under No. 2 cover glasses.

Amphioxus.

Material of this form from the Naples Biological Station fixed in sublimate-acetic, Zenker's and Lang's Fluids, and preserved in 70% alcohol was used.

10 mm. Whole Mounts.

The animals were stained in Delafield's Haematoxylin suffi-

ciently to indicate the branchial basket, nerve-cord and digestive tract. Then a slight tinge of Orange G was introduced for differentiation. The specimens were mounted in balsam under 22 mm. cover glasses with supports. Material stained in alum carmine was also found to be very satisfactory.

40 mm. Whole Mounts.

These specimens were merely dehydrated, cleared, infiltrated in balsam for several days and then mounted as previously described. They are excellent for the grosser morphologic features and for the nerves.

Cross and Parasagittal Sections.

The 40 mm. specimens were used. They were treated like the earthworm material from the 70% alcohol onward. All sections were cut 10 microns thick. The parasagittal sections were not so successful because of the larger size and greater difficulty of infiltration.

THE PROBLEM OF THE LOADED TABLE.

Mr. von Nardroff's interesting and suggestive discussion of this problem in the March SCHOOL SCIENCE AND MATHEMATICS stops at conclusions that are indeed "rather puzzling" if they are to be accepted as final, and doubtless a good many teachers of physics feel that there is still something to be said for the textbook answers.

The following experiment is instructive. Weights of 60, 20, 10 and 30 ounces were suspended from spring balances so adjusted that the points for suspension at the hooks were at the vertices of a six by eight inch rectangle, A B C D, Figure 1. The readings were then, of course, 60, 20, 10 and 30, and the points of suspension had fallen to A′, B′, C′, D′ in accordance with Hooke's Law. A stiff seven by nine 16 ounce board with screw hooks below A, B, C and D was then suspended from the spring balances and upon corresponding screw-hooks directly underneath these were hung the four weights. Readings were taken for the board alone and for the board with the weights and gave, after the allowance, 55 for *a* (at A), 25 for *b*, 5 for *c*, and 35 for *d* as was anticipated; the plane of A B C D had been rotated about the line TV, and the points A, B, C, D were then in the

positions a', b', c', d'. All the weighs were then suspended at W with precisely the same result.

The figure shows that the points B and D had been carried below B′ and D′ while A and C were supported above A′ and C′. It also shows that the rigidity of the board was responsible for the diminished pull at A and C, and the increased pull at B and D because it kept all these points in one plane, with resulting stress components acting against the load pressures at A and C and with them at B and D. Without the board, the triangle, A B C, was rotated about the line, H K, and the triangle, A D C, about L N.

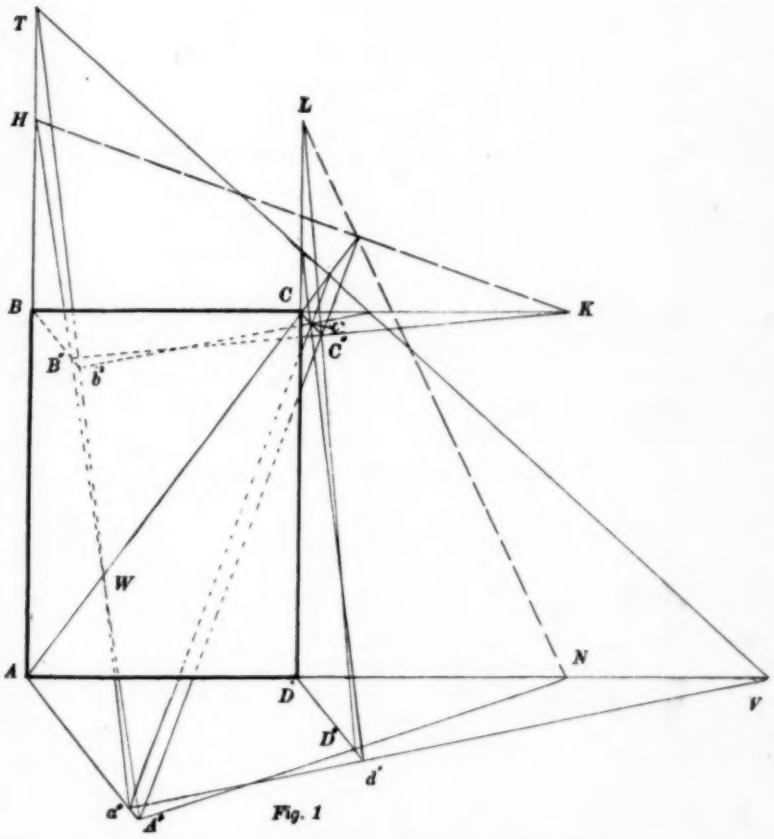


Fig. 1

It is evident that for any other special law of elastic yielding there will be a different but determinable set of values of a, b, c and d. Thus, by a rather tedious trial process, a similar figure was constructed for the case in which the elastic yielding varies

as the square root of the weight, and the pulls or pressures were found that would bring the lines H K and L N into coincidence with T V. Theoretically, this method might be employed for the law involving any root—the nth, and it would be found that as n is increased the line T V recedes from the rectangle, at first slowly and then more and more rapidly until at the limit it must be at an infinite distance, in which case the displacements of the points of suspension are infinitely small, or, as we might say, the same for all the forces acting.

Some interesting equations were met with in the working out of several of these figures, but without drawing them at all the forces may be computed by means of the equation $a^{\frac{1}{n}} - b^{\frac{1}{n}} = d^{\frac{1}{n}} - c^{\frac{1}{n}}$ which is readily shown to be true for any of the above mentioned laws and a particular application of which is found in Mr. von Nardroff's A—B = D—C. By trial of different values for a, b, c and d as representing the pulls upon the balances or the pressures at the feet of the rigid table with its 120 pound load the results were obtained which are tabulated below. The numbers in the first line are values of n, each designating the law to which the pressures (p) and roots (r) below it correspond. The trial pressures, so far as they could be determined by their moments alone, were a, 80—a, a—50, and 90—a. The results were computed to five and six decimal places, but only a sufficient number of these for the present purpose are here given.

	1		2		4		10		100		1000	
	p	r	p	r	p	r	p	r	p	r	p	r
a	55.	55.	57.8	7.6	59.0	2.8	59.6	1.51	59.96	1.042	60.	1.0041
b	25.	25.	22.2	4.7	21.0	2.1	20.4	1.35	20.04	1.030	20.	1.0030
c	5.	5.	7.8	2.8	9.0	1.7	9.6	1.25	9.96	1.023	10.	1.0023
d	35.	35.	32.2	5.7	31.0	2.4	30.4	1.41	30.04	1.035	30.	1.0034

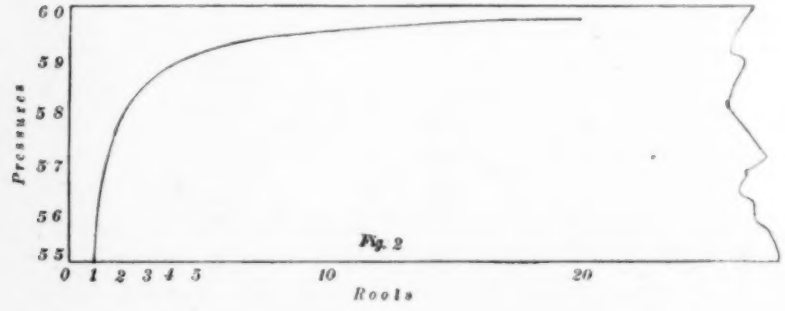


Fig. 2

Figure 2 shows the curve of the values of the pressure (a) at A. It meets the 60 line at an infinite distance but practically, so far as approximations with seven place logarithmic tables indicate, it coincides with that line for roots beyond the 200th.

We conclude as follows:

First, there is a definite set of values of the pressures at the feet of the loaded table for every law of elastic yielding, which values are constant so long as that law is applicable.

Secondly, the pressure at A (and this determines the others), which pressure is caused by the load at W acting in opposition to the stress which it meets at that point, increases as n of the successive laws increases and becomes a maximum at the limit when there is no displacement due to elastic yielding and therefore no stress to oppose it.

Finally, when the absolutely rigid loaded table with its four points of support in one plane rests upon a perfectly level and absolutely rigid floor (and these conditions are without doubt supposed in the problem as stated) the pressures are those of the tabulation and the textbook, namely, 60, 20, 10 and 30.

SORE EYES CAUSED BY FACE POWDER.

Face powder has its dangers the same as gunpowder. For several years occasional cases have come under the observation of oculists in which the patients, invariably women, complain of vision being blurred, inability to use the eyes for any length of time and severe itching of the lids. The slightest rubbing of the lids produces a marked redness of the eyes and only aggravates the itching. In severe cases the lids are frequently swollen from constant rubbing. There is a sticky, elastic secretion which, when being removed, pulls out in long strings. Microscopic examination of the secretion reveals masses of what appear to be crystals. Until recently no satisfactory explanation of the presence of these crystals in the eye has been given. Secretion taken from the eyes of two sisters suffering from this peculiar complaint were submitted to the professor of pathology of one of the university medical schools, who found that the crystals came from rice face powder. Seven other patients in which the same symptoms and microscopic conditions were found all used the same make of face powder. When the powder is applied to the face with a puff a portion of the fine dust is driven upward and lodges on the moist eyeball. The rice powder in the presence of the tears then becomes mucilaginous in character and is not washed from under the eyelids. The powder produces the irritation, which is aggravated by rubbing. Those who use a chamois-skin in applying the powder are less liable to cause the fine dust to arise, which probably accounts for the condition not being found in every woman using face powder. The condition is quickly relieved by flushing the eye with boric acid solution. The irritation rapidly disappears when the eyes are kept washed out with a soothing eye-wash.

GENERAL SCIENCE—SUMMARY OF OPINIONS UNDER REVISION.

By John F. Woodhull,
Columbia University, New York City.

We have had a very general response to the article published a year ago (School Science, Vol. 13, p. 499) calling for suggestions regarding material and methods to be used in teaching science.

The returns indicate a trend of opinion as follows:

Young people desire information from the whole field of science, especially from astronomy. This was a subject most popular in the schools half a century ago, but most neglected now.

The problems of real life are not differentiated, after the manner of specialized science, into astronomy, chemistry, physics, botany, zoölogy, and the like. The public needs unmistakably require a new organization of science instruction according to *projects.*

Many pupils in both elementary and high school are in a much more primitive state of mind in regard to all science than our school programs would indicate. Many are apparently blind and deaf to Nature's most evident teachings. They are in the depths of superstition about common things even while surcharged with academic formulas. Our secondary schools persist in articulating from above and not from *below.*

Few persons appear to know that they have the answers to most of their questions readily accessible in dictionaries, encyclopedias and readable books. Apparently we have deprecated the teaching of science from books too long and too successfully.

The greatest need, and likewise the greatest demand, among even the highly educated, is for *information* rather than *training* in science. All workers and students require training in their specialty, but in other fields they want knowledge in simple form and by the most direct method. Does this not indicate our course for general science teaching?

Natural science has moved from a position of great worth as a school subject to one of minor importance. Science teachers everywhere should regard it a high duty to make thoughtful effort toward bringing it back to its rightful place and value.

Attention is too sharply focused on teaching "subjects" as against teaching students those things that are important for them to know.

"Preparatory science" is unscientific. It is "desultory and scrappy," "unorganized and unorganizable." The schools reached the lowest point in real science instruction when, under the stress of preparing for higher institutions, they narrowed their work to "the forty quantitative experiments." At best the teaching was confined to vocabularies of technical words, definitions of new terms, and statements of "fundamental principles." Two hundred and seventy-five isolated paragraphs in "physics" prepared a boy for college.

Instruction in science throughout the elementary school and high school should be general rather than special. It should be a study of "projects" derived largely from experience. There should be books, not one, but many, and these should be used quite as freely as in history and in English. The teaching should be quite as informational as it is in those subjects. Apparatus should be used and experiments performed for the dramatic presentation of ideas. Dramatic presentation has been the most effective method of teaching throughout all ages. Constant appeals to daily experience should give the sense of reality. The natural and effective order is not principles followed by applications, but the reverse. From a multitude of experiences, facts and observations, arranged so as to illuminate one another, some few principles may be derived; if these principles can be shown to be fundamental and can be brought into immediate use. The trouble with most of the so-called "fundamental principles" is that they are never again met either in school or life and the majority even of enlightened men get on very well without having ever heard of them, or having heard, they have forgotten them because they did not prove to be fundamental to anything. A principle which occurs, or is likely to occur, so often that one cannot forget it, is fundamental, and few others need be considered. Principles are not to be taught merely for discipline and training, nor for use only in a remote future.

The study of "projects" in science will necessitate the breaking down of the boundary fences that have been erected between highly specialized sciences.

General science should be adapted to local conditions and may not be universalized. Many projects elaborated by ingenious and skilled teachers should be published in a series of small books or pamphlets for the use of pupils. Teachers may select from these as time, place and other circumstances require. Enough of this material may easily be prepared to occupy many years of

study on the part of pupils. What it is worth while to know from the fields of astronomy, botany, chemistry, geology, meteorology, physics, physiology, zoölogy, etc., may be thus acquired. Correspondence invited.

CATALYSIS.

By Truman J. Moon,
High School, Middletown, N. Y.

Catalysis is a process by which a chemical reaction is hastened or retarded by the presence of a substance, called a catalyzer, which, however, takes no part in the reaction and remains unchanged at the end.

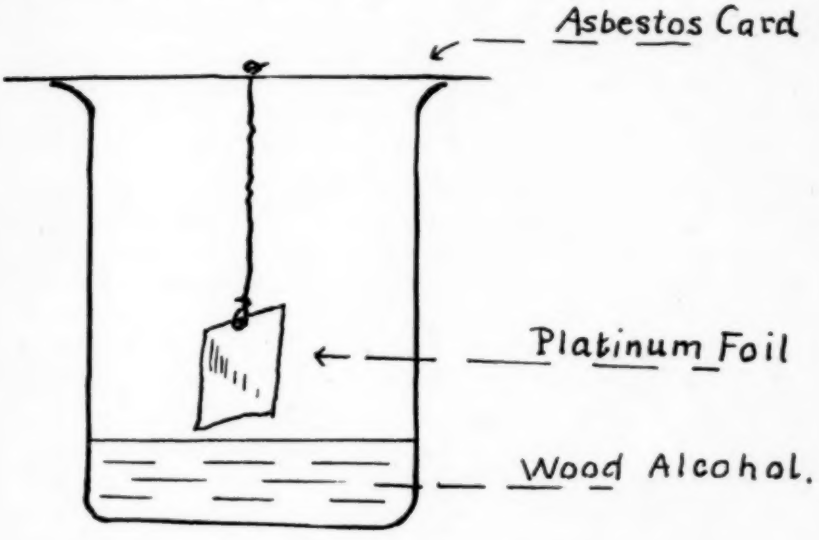
This is a very little understood process, though several industrial applications of it have been perfected, notably that of the contact method of making sulphuric acid, yet difficult as it is of explanation it can be easily demonstrated in several rather simple and very interesting ways.

In producing catalytic effects platinum is most often used, and although expensive, enough can be bought from any dentist to perform these experiments, and as it is not destroyed by use, it becomes a permanent asset.

One of the commonest reactions is that of displacing hydrogen from acids by means of zinc; if a bit of platinum foil be added to the generator, the reaction goes on with much increased rapidity; another simple case is that of hydrogen peroxide which will decompose rapidly in contact with platinum or with a tiny grain of manganese dioxide; tin will dissolve very little in hydrochloric acid alone, but in the presence of any compound of platinum the action is rapid, and there are many more such examples, but the one that I find most striking and unique is based on the use of a bit of platinum foil and some wood alcohol.

The procedure is as follows: Get a piece of the platinum foil, of half a square inch area or more if you can afford it; attach it to a wire of platinum or copper about two inches long; and suspend the wire and foil from the center of a card large enough to cover a tumbler or similar dish. In the bottom of the tumbler pour half an inch of wood alcohol and see that the foil will hang just free above it when the card is laid on the glass; the apparatus is now ready. Heat the foil to redness in gas or lamp flame and

at once place over the alcohol; a remarkable reaction takes place; the foil will continue red hot, glowing with a variable light, water will collect on the sides of the glass and a very strong odor of formaldehyde will be noticed.



The explanation is that the platinum, acting as a catalyzer, is causing the oxygen of the air to unite with the alcohol as in the following equation—$CH_3HO+O=H_2O+HCHO$.

It sometimes requires several heatings of the foil to start the reaction, but once started it is continuous, till the alcohol is all gone; I usually perforate the card with a few holes to let in more air or else lift the cover occasionally for that purpose, as the condition of the apparatus seems to indicate. It never fails to arouse much comment and it really looks very mysterious to see the platinum glowing, to feel the heat and see the products of the reaction, which would not go on at all if the catalyzer were absent; this has been the best demonstration of such phemonena that I have used, as it is simple, the products of the process are evident and the process is continuous.

TEACHING OF HOUSE-KEEPING.

By Mabel S. Keech.

Why neglect this important phase of school training? The teaching of house-keeping in public schools is a much discussed subject in our country, and its importance is being more and more realized, with the prospect that it will soon become a part of the school-girl's program. Domestic science includes very little outside of cooking, and the necessity of a preparatory course is being keenly felt.

An argument to discourage this forward step is occasionally given to this effect, that the home itself should be sufficient for such teaching, and that to introduce it into the school would cause indifference to parental duty. It is true that mothers should work with their little daughters in the home and encourage them to do the pleasant, small tasks while they are young, thus creating a homelike atmosphere, but many mothers cannot, others will not, and still others are not capable. Among the first class are those whose other home ties, such as caring for aged parents, or earning the living for the family, prevent proper overseeing of the child's work. In the second, are those who have not a large portion of patience, and who would rather do the work themselves than be hindered by a child; also those who leave all their work to servants, thinking themselves and their children above such menial service, or preferring to indulge in a constant whirl of social life. Scarcely less to be pitied are those who have been robbed of comforts because of poverty, and who are ignorant and careless because they have never had a home to care for except a furnished attic or basement room in a tenement house.

It stands to reason that girls who are handicapped by such conditions in the home, should have the instruction in school. Instead of parents feeling relieved of the responsibility and becoming more careless, their interest will be awakened by the enthusiasm of the girl over her school training, and they themselves will be incited to be more painstaking. Those mothers who are ideal in their home life surely will not object to their girls having an extra hour a week of house-keeping in school. Imagine the influence in the home when an eleven-year-old girl arrives, anxious to perform some duty which before has been disagreeable to her, but now has its charms because it has been presented to her in a delightful manner at school: the mother is amazed, and relieved that she can trust her daughter with these particular duties, the older

brothers and sisters are proud and pleased, and the father is ready with his words of encouragement.

Did you ever see a girl clap her hands in glee because she is to be allowed to scrub the floor? She will do this in a class room, and if the teacher grasps her opportunity by expressing her pleasure at the pupil's diligence, and at the results obtained, also by persuading her that the work at home can be as full of joy if done in the right way, the girl will go to her home with the desire to please, and with the spirit of helpfulness.

In the grammar grades a class begins its course in domestic science, which is one of the most important studies in the industrial line, because of this direct bearing upon the health of the community. The instructor is constantly hindered because many of the girls have not had their ideas of neatness, system, and care, sufficiently developed. If this class could have at least one year of house-keeping aside from cooking, before entering upon this special course, a better grade of work would be done and more general satisfaction experienced. The care of the kitchen, including neat dish-washing, cleaning cupboards and keeping them orderly, scrubbing tables, keeping floor swept and stove clean, these lessons carefully learned before those in cooking begun, would be invaluable in the domestic science class-room. Table-setting and serving are no less important, as every complete domestic science course does not neglect this part. Even washing, ironing, and bed-making are closely related, as they cultivate a desire for all-around tidiness.

Would not a class in the branches mentioned, conducted in a manner attractive to younger girls, by using toys of a large size for equipment, and songs to intersperse the lessons, be valuable as a course preparatory to the cook-school? The fact must also be taken into consideration that some pupils leave school before reaching the grade for domestic science, and thus are entirely deprived of this line of training. A class in general house-work can be introduced into intermediate grades, in order that they may learn the fundamental rules of housekeeping.

The economic and health values of such a course must not be overlooked. No way of teaching a child respect for the furnishings of a home, that she may not mar nor waste them, is more impressive than that of having a share in the care of them. And any girl of eight or ten can be made to understand that dirt and filth around the house are not companions of good health. The coming generations of mothers, of the poor, rich, and middle classes, will be more efficient housewives, more cheerful home-

makers; yes, even the divorce problem will in a measure be settled, when more principles of house-keeping are instilled in the hearts and minds of all our young girls of today.

THE GREAT GLACIERS OF MOUNT RAINIER.

That the glaciers in Mount Rainier National Park are equal to the celebrated glaciers of the Alps is brought out in a striking manner by Mr. F. E. Matthes, in a pamphlet entitled, "Mount Rainier and Its Glaciers" just issued by direction of Secretary Lane. "The impression still prevails in many quarters," says Mr. Matthes, "that true glaciers, such as are found in the Swiss Alps, do not exist within the confines of the United States, and that to behold one of these rare scenic features one must go to Switzerland, or else to the less accessible Canadian Rockies or the inhospitable Alaskan coast. As a matter of fact, permanent bodies of snow and ice, large enough to deserve the name of glaciers, occur on many of our western mountain chains; in the Sierra Navadas of California, and farther north, in the Cascade Range.

"Easily king of all is Mount Rainier. Over 14,000 feet high, it is overwhelmingly impressive, both by the vastness of its glacial mantle and by the striking sculpture of its cliffs. The total extent of its glaciers amounts to no less than 45 square miles, an expanse far exceeding that of any other single peak in the United States. Many of its individual ice streams are between four and six miles long and vie in magnitude and in splendor with the most boasted glaciers of the Alps. Cascading from the summit in all directions, they radiate like the arms of a great starfish. All reach down to the foot of the mountain and some even advance considerably beyond.

"Mount Rainier stands on the west edge of the Cascade Range, overlooking the lowlands that stretch to Puget Sound. Seen from Seattle or Tacoma, 60 and 50 miles distant, respectively, it appears to rise directly from sea level, so insignificant seem the ridges about its base. Yet these ridges themselves are of no mean height, as they rise 3,000 to 4,000 feet above the valleys that cut through them, and their crests average 6,000 feet in altitude.

"The crowning snow mound, which was once supposed to be the highest point in the United States, still bears the proud name of Columbia's Crest. It is essentially a huge snowdrift or snow dune, heaped up by the westerly winds. Driving furiously up through the great breach in the west flank of the mountain, between Peak Success and Liberty Cap, they eddy lightly as they shoot over the summit and there deposit their load of snow."

This publication, which includes a sketch map and 24 illustrations showing the ice fields, and which may be obtained for 15 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C., contains detailed descriptions of the principal glaciers and accounts of the peculiar phenomena of the ice fields, such as the depressions known as snow caps, the ice cascades, the slabs of rock called glacial tables, and the insects which thrive on the icy fields of snow.

NEW DEPARTMENT OF HOUSEHOLD ECONOMICS IN THE CENTRAL ASSOCIATION.

By Minna C. Denton,
Ohio State University, Columbus.

With the opening of this department begins, in a modest way, the work of the new section for household economics in the Central Association of Science and Mathematics Teachers.

It is the province of this section, as the present committee on organization sees it, to discuss materials, subject matter, methods, for teaching high school work in domestic science and art. Furthermore, it is the hope of the committee that this department in School Science may comprise not merely a collection of articles written by experienced teachers and recognized authorities, but also a medium of exchange among teachers, to which the youngest and most recent recruit in the ranks may contribute her experience or direct her plea for counsel or information. Our subject is developing so rapidly and feeling its way into so many new avenues of usefulness, that it behooves us to keep within speaking distance of each other, to learn from each other's experience, to be ready to cast aside the old and take on the new as soon as it shall have been proved the better way.

Why Should We Desire Alliance with C. A. S. and M. T.?

To discuss a single one of a number of good reasons:

Because they are looking towards entering more and more extensively, the field of applied science; and because we stand in such desperate need of help in precisely this field. E. g., how are we to judge of the relative merits of refrigerator wall-construction and circulation in the different designs offered for sale, except from the manufacturer's representations—how shall we tell what temperature, humidity, and ice-consumption to expect with a five-inch, ten-layer insulation of dead air spaces, flaxlinum, and asbestos fiber, or with any of the many other constructions to be met with in the market—except by the time-consuming and (for most of us) impossible task of trying them out in our homes or laboratories and taking accurate scientific measurements? Yet here is a question that might attract the boy who wants a problem in applied physics; and when he has worked it out, we shall no longer have to depend upon such data as "Mrs. Smith has that kind and likes it," in our own selection for an altogether different set of working conditions and expectation.

And so with construction and performance of vacuum clean-

ing apparatus; with temperature attained in coffee percolators (*not* a boiling temperature, by the way, no matter how hard it may bubble) and the consequent effect upon tannin, caffein and aroma extraction; with the destruction wrought by various alkalies, acids and grits found in many widely used cleaning agents, upon the various constituents of a porcelain-enamel sink-lining; with the possible deleterious action of food acids and cooking processes upon enamelled cooking utensils (did you know that in the school laboratories of one large city, supervisor and teachers disapproved so thoroughly of these, as to order all inside vessels of double boilers replaced by aluminum?); with the dangers of the quick chemo-electrical method of cleaning silverware by means of a salt-and-soda solution in contact with bright aluminum or zinc—a problem which is being investigated by one of the Chicago high school chemistry departments, where they hope soon to be able to tell us how far the patented devices using this process are likely to affect jewellers' time guaranties for plated sliverware—and also by good Housekeeping Institute (see Good Housekeeping, August, 1914).

A NOTE.

In a recent text in sanitation we find this sentence: "Forty girls around a lady dressed like a nurse, cooking dainties on little gas stoves, may learn cookery scientifically, but they may not learn about food from the point of view of a home-maker."

This modestly expressed doubt is often, alas! more or less justified. (Not that we deprecate a severely plain and washable costume for the teacher of food work; but that the problem of correlating home and school work, which the introduction of home economics was supposed so beautifully to solve, sometimes even yet fails to disappear completely!) The difficulty is, perhaps, that we have too often allowed the designation "cooking teacher" to measure the scope of our work, and have neglected or shirked entirely the more complex problems of home economics. "Back to the home!" is the slogan of the modern classroom teacher.

Here follows an account of the way in which one teacher of food classes contrived, simply by the ordering and arrangement of lessons in the course, to bring her work into close touch with home duties and everyday opportunities:

ELEMENTARY FOOD WORK BROUGHT INTO RELATION WITH PREPARATION OF MEALS.

By Alice Titsworth Houston.
Chicago, Ill.

When it was suggested to me during my last year of preparation, for teaching that "three meals a day" would be a good working basis for the presentation of cooking, the idea struck me most favorably. In the first place it gives both pupil and teacher a definite object: for each girl to acquire the ability to go into her own kitchen and systematically and quickly prepare a good meal—not haphazard and isolated dishes, but a well-balanced and attractive meal.

Again, it is a logical plan, beginning with the simple and working to the elaborate meal; beginning with the easily prepared dishes of the simple meal, such as cereals, and working to those which are more difficult of preparation, such as breakfast breads, egg dishes, etc.

It so happened that I had an ideal opportunity for trying out my plans, for I went to a wide-awake little western city to which the work was comparatively new, where I had full charge of the domestic economy department.

The first lessons were on cereals—rice with date border, cold cream of wheat mold with bananas, oat meal with evaporated fruit, etc. The cooking of the cereal gave the necessary repetition, and the fruit the necessary variety both of taste and principle of preparation. Also we used the fireless cooker here. From cereals we went on to other simple breakfast dishes such as baked potatoes, with creamed dried beef, fish balls, cream potatoes with bacon, etc. I was careful to give lessons every now and then on the use of left-overs.

Though we called our next general division, "breakfast breads," we might have said "doughs and batters," for by the time we had finished the children were encouragingly conversant with stiff and soft doughs, drop and pour batters, the relation of eggs and liquids, eggs and baking powder, etc. Here also doughnuts gave an opportunity for deep-fat frying, corn bread for the use of sour-milk and soda, and waffles for expert manipulation.

My high school classes met twice a week, the grade-school classes, once. I used the same general plan for both, as all were beginning classes, but I gave the high school classes more extensive theory and practice along each line we took up. This

simplified my own work in regard to marketing and recipes. In February when eggs were plentiful and cheap we were logically ready for egg lessons. As the work with cereals and potatoes had given an opportunity for the study of starchy foods, so eggs gave a similar opportunity of the study of proteins, not so completely as though the working basis had been the five principles, but completely enough to give the pupils a fairly comprehensive idea of the principles.

When we had completed the work on breakfasts each class prepared and served a complete breakfast. This brought in the work on setting the table and serving.

Before school closed in June we had begun on luncheons, but as I left the work at that time I was unable to try out my entire plan. But this much I can say, the general plan had worked far better than I had dared hope. It seemed to give a logical place to each principle and theory taught in a well-rounded course in cookery.

HOW I CONDUCT A PRACTICAL EXAMINATION IN FOOD PREPARATION.

By Katherine Livingston,
Lewis Institute, Chicago.

I find that a very helpful review for a class in cooking is a practical examination upon the recipes made in the class room. I conduct it by letting students draw slips containing incomplete recipes written in this way:

Prepare Baking Powder Biscuits using:

Flour	Fat	Salt	B. P.	Liquid
?	$1\frac{1}{4}$ tsp.	$\frac{1}{8}$ tsp.	$\frac{1}{2}$ tsp.	$1\frac{1}{2}$ tsp.

Write directions for combining ingredients and for baking.

Each girl draws a slip and answers the questions. After they are approved by the instructor she sets to work to make her product. If this takes only a short time she draws another slip and makes the second article. As each one is finished it is arranged upon a table, and at the end of the period criticised by the class. This exercise impresses definite proportions of ingredients of at least two dozen recipes upon the students and, because of the careful examination of each finished article by the class, promotes careful manipulation.

THE BED, ITS EQUIPMENT AND CARE.

By Minna C. Denton.
Ohio State University, Columbus.

(These lessons may be given in connection with courses on House Decoration and Furnishing, Home Nursing, Household Management, Home Sanitation, Housekeeping. Lack of school equipment need not prove an insurmountable obstacle; it is usually possible to borrow from homes or from retail shops or from manufacturers, the articles most needed. Future installments deal with choice of mattress, springs, coverings, making of bed.)

I. Historical. Ancient bed designed to afford security of person from enemies, and protection from rigorous climate in unheated rooms; hence early type (as in Sweden, early German, present primitive Netherlandish) was a wall closet securely built and locked. Transition forms from this to Colonial fourposter with heavy hangings. Adoption of historical designs only as they fit modern living conditions.

Also, bed used largely in past as a means of display for costly stuffs and skill in handiwork. Development of modern idea that perfection of adaptability to needs of user and caretaker, and not display, is keynote in furnishing.

II. Position of bed in room. Not so that sleeper's head will be in "dead air" at corner of room or against wall; move bed from wall at night or make up so that head comes at free end of bed in circulating air; use screen if necessary, but accustom sleeper to contact with more or less moving air, training body gradually to increase its resistance and thus help him to avoid taking colds and various infections. Placing of sick bed so it may be reached from all sides.

(Discuss necessity for cross ventilation in bedrooms by means of windows, doors, transoms; necessity for opening windows freely at night; use of blinds, shades, curtains, etc. so as not to interfere with ventilation draught. Discuss advantages of outdoor sleeping where noise, soot and dust, dampness, light or publicity do not prevent, and some of the methods for obviating these difficulties. Discuss location, construction and safe-guarding of sleeping porches; easy access to them through double French windows or doors which permit bed to be rolled in and out; how to make up beds for outdoor sleeping in bitter weather. If desirable, discuss use of window tent; special construction of window to secure best ventilation possible; special devices for in-

creasing ventilation efficiency of ordinary windows under unfavorable conditions; advantages of casement windows over double-hung, in this respect; use and construction of sleeping tents or shelters. Bibliography: Carrington, Fresh Air and How to Use it; Flick, Knopf, Huber and other authorities on treatment of tuberculosis, give much helpful instruction.

Discuss essentials of good ventilation; (freshness of air usually dependent more upon physical conditions of coolness, moderate degree of humidity, and good circulation, than upon chemical composition.)

III. Size of bed, usual dimensions of single, three-quarters, double bed. 6′6″x36″, a desirable size, especially for sick room. Eventual passing out of use of double beds; need of each individual for his own undisturbed air-and-bed-space, lessened tendency to sagging of springs and mattress in single bed, greater ease with which single beds can be handled, greater ease with which sick person can be handled in single bed.

Height of bed in sick room important (saves strain on nurse's back from stooping, easy to clean under bed); 25 inches from side piece to floor (including height of castor) desirable; possibility of raising legs of ordinary bed by improvised wooden blocks or extra-size castors.

Castors. Large size promotes ease in moving bed about the room (e. g., small wheels seen on many hospital beds); soft or polished surface prevents injury to the floor.

IV. Modern bedsteads, materials and design. Woods—mahogany, walnut, oak, ash, birch, cherry, maple, pine, etc. Simplicity of design as reflecting good taste and enhancing sanitary qualities; harmony of design and finish with other bedroom furniture and furnishings. Greater tendency of wood to absorb moisture and odors, greater difficulty in thorough cleaning and disinfection, greater liability to harbor vermin, as compared with metal bed; influence of these facts upon choice, especially for sick-room. Objections to heavy solid head-board and foot-piece; their weight and difficulty of moving them, obstruction offered to circulation of air.

Metals,—brass and painted iron tubing or rods. Compare with woods as above. Consider amount of care needed by various brass finishes, by a white enamel paint; possibility of painting iron to harmonize with wooden furniture of room. Details of construction; frame of few large plain hollow tubes with few angles and smooth joints, easier to care for than that of many

ornamented smaller rods; extensive ornamentation a sign of cheapness.

Special types of construction, as folding beds, disappearing beds, couch beds, davenport beds, table beds, etc., to be discussed as interest of class may warrant; comfort, stability, convenience, sanitary and other advantages and disadvantages.

Special framework, which can be attached to sick-bed for elevating head with ease to any desired angle. Careful study of cost in all materials and patterns.

EXPERIMENTAL COOKING IN THE HIGH SCHOOL.

By Grace Hood,
School of Education, University of Chicago.

The amount and nature of experimental cooking in the high school would depend primarily on the type of school and the amount of science which the students have as a background.

For the average high school girl experiments having a clearly defined practical application would undoubtedly meet the needs of the student better than those of a chemical nature. As a matter of illustration, the housewife is certainly more interested in the practical results from using various brands of baking powder under similar conditions than in knowing the number of cubic centimeters of gas given off by one teaspoonful of each. She is more interested in knowing the results of using various proportions of fat, sugar, liquid, flour, and the like in a mixture than in a chemical test showing the presence of each.

Physical changes that can be seen by the naked eye, or by use of a microscope, are more apparent to the high school student than chemical changes. However, a group of students who have chemistry as a background would undoubtedly be interested to know that the comparative smoothness of one candy mixture was brought about by a chemical change which did not occur in another, and similarly with other chemical changes produced in cooking, but these are often beyond the understanding of the average girl of high school age.

The amount of experimental work would depend on the length of the course and the object of the course, and also on the social need of the student group. The main object is the preparation of foods for the table, how much does your group need to know in regard to the technique of cooking and serving, food values, cost of food, food production and manufacture, and of the underlying principles involved in the preparation of food?

HOME ECONOMICS COURSES AS THEY ARE BEING ARRANGED IN MODERN HIGH SCHOOLS.

By Helen Grant,
Minneapolis High School.

Minneapolis. We have had home economics in the high schools just two years, so that much is still in the tentative stage. We offer a straight home economics course covering four years: two years of work in sewing and applied art, two in cooking and applied science; alternating sewing and cooking by semesters. In the "sewing semester" sewing and art come on alternate days for two periods of forty minutes each; and similarly with the cooking and science. One teacher takes the cooking classes, another the science; the program is so arranged that each teacher cares for six classes of twenty-four each, through the year,—though it is true that last year not quite all classes were full to the limit. The science work is taught by teachers with home economics as well as science preparation, in laboratories fitted up in much the same way as are the other high school science laboratories.

We also offer in the general course, two years' work in home economics, it being optional with the pupil whether the two years are spent in cooking classes, sewing classes, or one in each. So far, Home Economics and General Course pupils have worked together in the same sections.

Semester 1. Cooking, general review of the basic principles taught in the grades, laying special emphasis on method and sequence (as in batters and doughs).

Science, household bacteriology. Bacteria, yeasts, and molds; water, air, etc.

Semester 2. Vegetable foods, using botanical classification and varying the methods of preparation as much as possible. Roots, tubers, bulbs, leaves, stalks, fruits, seeds (except cereals).

Science, grass and microscopic plant anatomy, and physiology.

Semester 3. Cereal foods studied in order of sequence of starch content; thorough study of batters and doughs.

Science, chemistry; including such simple work as is necessary for food study—e. g. with carbohydrates, hydrocarbons, fermentation.

Semester 4. Cooking of proteins; general summing up of all previous work by extensive exercises in preparation of meals (cost, planning menus for various occasions, utilization of left-overs, balanced rations, infant and invalid cookery). Of course

some work in preparation of meals is given in every semester, but usually most of the entertaining is done by these 4th semester classes.

Science, chemistry completed with work on proteins, chemistry of cleaning and laundry work. Household management and study of the home.

A HIGH SCHOOL HOME NURSING COURSE.

By Anne Green,

De Kalb, Ill., High School.

Home nursing was taught in the DeKalb Township High School this past year as part of the course in home economics. One month with a forty-five minute period every day was all the time we could allow for it. Our purpose was to give the girls the principles underlying sick-room administration and enough technical skill to make them intelligent in caring for the minor ills which so frequently visit the home. Courses in home and municipal sanitation preceded the work and all the pupils had had physiology and hygiene. They understood the need of perfect cleanliness in the care of the sick. This gave a good apperceiving basis. We used no text, but some outside reading was required.

We sifted the work of nursing down to two main objects, namely, to place the patient under conditions such that nature and medicine can effect the cure, and secondly, to make the sufferer as comfortable as possible both physically and mentally. It was a simple matter to develop the lessons with these two objects in view, and each girl worked them out for herself. For example, in the lesson on cleaning the sickroom, what should be their method of procedure so as to avoid dust, noise and confusion which would render the patient uncomfortable, but still do away with every possible bit of dirt whch carries with it harmful bacteria. It required little effort on the part of the teacher to get the ideas of the class. Then we discussed them and chose the best method. In the lessons on emergency nursing we divided the accidents which might come to the body according to the body system affected, such as the nervous system, the circulatory system, etc. After a discussion of such an accident the girls would suggest a remedy, or if they could not offer it themselves they were ready for instruction from the teacher and could see a reason for such a means of treatment. This also helped greatly in avoiding the

spirit of fun so rampant in a home-nursing class. It seems such a joke to be bandaging the strong arm of a fellow student. It gives dignity to such work when they have approached it in a logical, reasonable manner. We try to make them understand the necessity of self-control at all times and that this must be cultivated if we are to have it in times of emergency.

Our equipment consisted of a hospital cot and a modest emergency case. Next year we hope to have a complete bed. A teacher can have her class practice with a doll bed, but of course it is much better to have a complete, full-sized, three-quarter bed.

A brief outline of the subject matter is given below:

1. The nurse—how she should care for herself, her clothing, manner.
2. The room—choice of the sickroom, its furniture, lighting, ventilation and care.
3. The bed—equipment of the bed, how to make it, how to change the sheets with the patient in bed.
4. The care of the patient—bathing, taking pulse, temperatures, respirations, giving of medicine, etc.
5. Disinfectants, antiseptics, and fumigation.
6. Hot and cold applications, poultices and counter irritants.
7. Bandaging, and emergency nursing.
8. Preparation of the invalid's tray.

Every effort was made to teach discrimination on the part of the student. Every busy physician laments the many unnecessary calls he has to make when a little skill on the part of the mother would have saved his time and the family pocket book. But we hear equally as often how many times if the physician had been called in time a life might have been saved.

A little time was given also to discussing the simple home remedies and patent medicines of which we hear so much. The implicit faith mothers put in certain things is passed on to their daughters and it requires tact and care on the part of the teacher to show the futility of these methods, by substituting modern treatment. Due to lack of time, it was necessary to eliminate much that might have added to the course. But too much detail is cumbersome and if the work is simplified and just essentials taught they are much more likely to be remembered than a compilation of isolated facts. The mind of the high school girl is intensely practical where work of this kind is concerned and we must make them understand the necessity of a knowledge of home-nursing if we are to accomplish good and lasting results.

SOME COMMON ERRORS HEARD IN HOME ECONOMICS CLASS ROOMS.

1. "Moist heat causes the starch cells to swell and burst their cellulose walls."

This statement is an aggregation of gross inaccuracies. First, cells are not made of starch; second, the cells do not burst, as a rule; third, that membrane which does burst is not made of cellulose.

If you are speaking with reference to a prepared corn, wheat, potato or other starch or flour, then the term "starch cell" can by no stretch of the imagination be considered correct, because starch is a nonliving substance. In these flours the living cell of the wheat or other seed has been broken up and the powder consists largely or wholly of starch *grains,* which do swell and burst their starchy (*not cellulose*) membranes.

If you refer to a starchy food in its natural state—the potato tuber or the wheat kernel, let us say—then it is well to remember these two facts:

1. A living, that is to say, a complete cell, is composed essentially of protoplasm jelly arranged in differentiated portions, and the starch grains which it may contain are a by-product of its activity; so that the term "starch-bearing cell" would be much more nearly accurate.

2. It is usually the case, in dealing with a starchy food that has not been thoroughly dried, that application of moist heat (as in boiling a potato) ruptures only a very few of the cell walls, hardly 10 per cent of them. The starch grains swell, it is true, and the starch-bearing cell expands, rounds out, and separates more or less from its neighbors, due to the water it has taken in; but the cellulose wall is highly elastic, and even the most vigorous mashing and grinding of boiled potato with ordinary kitchen utensils or with mortar and pestle, fails to rupture most of the walls. The difference in texture between the cooked and uncooked potato is due largely to the splitting apart of the cells as they swell—just as the mealiness of a very ripe apple is due to the same thing.

No. 2 will appear in the November issue.

PROBLEM DEPARTMENT.

By I. L. Winckler.

Readers of this magazine are invited to propose problems and send solutions of problems in which they are interested. Problems and solutions will be credited to their authors. Address all communications to I. L. Winckler, 32 Wymore Ave., E. Cleveland, Ohio.

Algebra.

386. *Proposed by Norman Anning, Chilliwack, B. C.*

The H. M. (harmonic mean) of three quantities is the same as the H. M. of the three H. M.'s found by taking the quantities in pairs.

I. *Solution by T. M. Blakslee, Ames, Iowa, and A. M. Harding, Fayetteville, Arkansas.*

Let the quantities be a, b, c.

Their H. M., i. e., the reciprocal of the H. M. of

$$\frac{1}{a}, \frac{1}{b}, \frac{1}{c} \text{ is } \frac{3abc}{ab+ac+bc}.$$

The three H. M.'s when taken in pairs are

$$\frac{2ab}{a+b}, \frac{2ac}{a+c}, \frac{2bc}{b+c}.$$

Their H. M. is

$$\frac{24a^2b^2c^2}{(a+b)(a+c)(b+c)} \div \left[\frac{4a^2bc}{(a+b)(a+c)} + \frac{4ab^2c}{(a+b)(b+c)} + \frac{4abc^2}{(a+c)(b+c)}\right] = \frac{3abc}{ab+ac+bc}.$$

II. *Solution by the proposer.*

The definition of the H. M., x, of a and b may be written

$$\frac{1}{x} + \frac{1}{x} = \frac{1}{a} + \frac{1}{b}.$$

By analogy the H. M., h of a, b, c is given by

$$\frac{1}{h} + \frac{1}{h} + \frac{1}{h} = \frac{1}{a} + \frac{1}{b} + \frac{1}{c}.$$

Let l, m, n, H be the H. M.'s respectively, of b and c, c and a, a and b, and l, m, n.

$$\frac{3}{H} = \frac{1}{l} + \frac{1}{m} + \frac{1}{n}.$$

$$\frac{6}{H} = \frac{2}{l} + \frac{2}{m} + \frac{2}{n} = \left(\frac{1}{b} + \frac{1}{c}\right) + \left(\frac{1}{c} + \frac{1}{a}\right) + \left(\frac{1}{a} + \frac{1}{b}\right)$$

$$= \frac{2}{a} + \frac{2}{b} + \frac{2}{c} = \frac{6}{h}.$$

$\therefore$ H $= h$.

388. *Proposed by F. Eugene Seymour, Trenton, N. J.*

A man's age in 1887 was equal to the sum of the digits in the year of his birth; how old was he?

I. *Solution by R. T. McGregor, Coleville, California.*

The thousands digit and the hundreds digit are evidently 1 and 8, respectively.

Let x represent the tens digit and y the units digit; then according to the conditions

$$1887-(1000+800+10x+y) = 1+8+x+y$$

or $11x+2y = 78$. $\therefore\ y = 39-5x-x/2$. Since y is an integer x must be even.

The only admissible integral values of x and y are $x = 6,\ y = 6$. Hence he was born in 1866.

II. *Solution by Norman Anning, Chilliwack, B. C.*

Suppose the man was born in the year whose digits are a, b, c, d.

$$1887-1000a-100b-10c-d = a+b+c+d.$$

$$\therefore\quad 1887 = 1001a+101b+11c+2d.$$

The terms on the right cannot exceed 1001, 909, 99, 18.

Since $909+99+18<1887$, a cannot equal 0, and must equal 1.

$$\therefore\quad 886 = 101b+11c+2d.$$

As before it follows that b must equal 8.

$\therefore\ 78 = 11c+2d$ and from this comes the single solution $c = 6,\ d = 6$.

The man's age $= a+b+c+d = 1+8+6+6 = 21$.

Geometry.

388. *Proposed by F. Eugene Seymour, Trenton, N. J.*

If similar triangles be circumscribed about and inscribed in a given triangle, the area of the given triangle is the mean proportional between the areas of the circumscribed and the inscribed triangles.

I. *Solution by Elmer Schuyler, Brooklyn, N. Y., and N. P. Pandya, Baroda, India.*

Let the given triangle be ABC, and the circumscribed and inscribed triangles be xyz and $x'y'z'$, respectively.

We know that xx', yy', zz' are concurrent.

Let o be the point of concurrency.

$\Delta Ax'y' = \Delta x'yy'$. $\therefore\ Ax'oy' = \Delta ox'y$.

Also $\Delta ox'y' : \Delta ox'y = oy' : oy = ox' : ox = oz' : oz$.

$\therefore\ \Delta ox'y' : Ax'oy' : \Delta oxy = \overline{ox'}^2 : \overline{ox'}\cdot\overline{ox} : \overline{ox}^2$.

Similarly, $\Delta oy'z' : cy'oz' : \Delta oyz = \overline{ox'}^2 : \overline{ox'}\cdot\overline{ox} : \overline{ox}^2$

and $\Delta oz'x' : Bz'ox' : \Delta ozx = \overline{ox'}^2 : \overline{ox'}\cdot\overline{ox} : \overline{ox}^2$.

Hence by the laws of composition in a proportion

$$\Delta x'y'z' : \Delta ABC : \Delta xyz = \overline{ox'}^2 : \overline{ox'}\cdot\overline{ox} : \overline{ox}^2$$

$$\therefore\ \Delta ABC = \sqrt{\Delta x'y'z'\cdot\Delta xyz}.$$

II. *Solution by Norman Anning, Chilliwack, B. C.*

Given triangle ABC, inscribed triangle DEF, and circumscribed triangle PQR similar to DEF and similarly placed.

Let area ABC $= s$, area DEF $= t$, and ratio PQ : DE $= z$.

Since EF is parallel to QR,

$$\Delta QEA+\Delta AFR = \frac{QR}{FE}\cdot\Delta AFE = z\cdot\Delta AFE.$$

Similarly,

$$\Delta RFB+\Delta BDP = z\cdot\Delta BDF.$$
$$\Delta PDC+\Delta CEQ = z\cdot\Delta CED.$$

Adding,

$$\Delta PQR-\Delta ABC = z(\Delta ABC-\Delta DEF)$$

or

$$\Delta PQR = s+z(s-t).$$

But since similar triangles are to each other as the squares of like dimensions,

$$\Delta PQR = z^2 \cdot \Delta DEF = z^2 t.$$

$$\therefore \quad z^2 t = s + z(s - t)$$

or $$z^2 t + (t - s)z - s = 0.$$

$$\therefore \quad z = -1, \text{ or } \frac{s}{t}.$$

$z = -1$, is inadmissible, since then $\Delta PQR = \Delta DEF$.

When $z = \frac{s}{t}$, $\Delta PQR = s + \frac{s}{t}(s - t) = \frac{s^2}{t}$.

$$\therefore \quad \Delta PQR : s = s : t$$

or $$\Delta PQR : ABC = ABC : DEF.$$

389. *Proposed by Irvin E. Kline, Atlantic City, N. J.*

Is a right section of an oblique circular cylinder a circle? Prove your answer.

I. *Solution by G. I. Hopkins, Manchester, N. H.*

Let AMB be one base of an oblique circular cylinder and AND a right section. Also let AF and BE be elements at opposite extremities of the diameter AB. Let CK be the line joining the centers of the bases, intersecting the section AND at H.

The $\angle FAB$ being the maximum, and $\angle ABE$ the minimum angles, which any of the elements make with the base, between these two there will be an element and a radius perpendicular to each other.

Let MP be that element and CM the radius.

Draw CN and HN.

Since CM $\perp$ MP, CN$>$CM. $\therefore$ CN$>$AC. CH is $\perp$ to both AN and HN, $\therefore$ HN$>$AH. $\therefore$ AND cannot be a circle.

II. *Solution by A. M. Harding, Fayetteville, Arkansas.*

Let ABC be the base, centre O, and A′B′C′ be the right section, cutting the axis of cylinder at O′. Let AA′ and CC′ be elements at the extremities of the diameter AC. Suppose OB and O′B′ parallel.

Let the plane of the right section cut the plane of the base in RS. Suppose P and P′ in the perimeters of the base and the section, respectively, are on the same element. Then O′P′ is the projection of OP on the plane A′O′P′. Hence all the radii of the circular base are shortened (in different ratios) by the projection, except OB which is parallel to the plane A′O′P′.

In fact the section is an ellipse whose semi-major axis is O′B′ and semi-minor axis is O′A′ = O′B′$\times$cosine of the angle between the planes.

It is possible however to so cut the cylinder that the section will be a circle. Draw O″R so that O′R bisects the angle ORO″. Then the plane through O″R and RS (or any parallel plane) will cut the cylinder in a circle.

390. *Proposed by R. T. McGregor, Coleville, California.*

A cylinder one foot in diameter contains water to a depth of four inches. Find the diameter of a ball which when put into the cylinder will be just covered by the water.

Solution by I. N. Warner, Platteville, Wisconsin.

Let x = the number of inches in diameter of the sphere.

Then $x - 4$ = rise in height of water when the sphere is put in cylinder.

$\therefore$ volume of a cylinder 12 inches in diameter and $x - 4$ in height = volume of the ball.

$$\therefore \quad (x - 4)36\pi = \tfrac{1}{6}\pi x^3$$

or $$x^3 - 216x + 864 = 0.$$

Factoring, $(x - 12)(x^2 + 12x - 72) = 0.$

$x = 12;\quad 6\sqrt{3}-6;\quad -6\sqrt{3}-6.$

The admissible values are $x = 12$, $x = 6\sqrt{3}-6 = 4.392+$.

CREDIT FOR SOLUTIONS.

366. M. G. Schucker. (1)

386. Norman Anning, T. M. Blakslee, H. W. Brinkman, A. M. Harding, N. P. Pandya, Elmer Schuyler. (6)

387. Norman Anning, Niel Beardsley, T. M. Blakslee, H. W. Brinkman, Walter C. Eells, Elizabeth H. Johnston, A. M. Harding, G. I. Hopkins, Daniel Kreth, A. L. McCarty, R. T. McGregor, N. P. Pandya, Elmer Schuyler, H. Polish, R. Wylie Wilkinson. (15)

388. Norman Anning, N. P. Pandya, Elmer Schuyler. (3)

389. T. M. Blakslee, A. M. Harding, G. I. Hopkins, Elmer Schuyler. (4)

390. Norman Anning, Niel Beardsley, R. E. Bowman, H. W. Brinkman, Walter C. Eells, A. M. Harding, William W. Johnson, Daniel Kreth, H. Polish, Gertrude L. Roper, Elmer Schuyler, I. N. Warner. (12)

Total number of solutions, 41.

PROBLEMS FOR SOLUTION.

Algebra.

401. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Solve:
$$x^5+y^5 = x^6+y^6.$$
$$x+y = 2.$$

402. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Find the nth term and the sum of n terms of the series

$$5^3+11^3+19^3+29^3+\ \ldots$$

Geometry.

403. *Proposed by L. E. Lunn, Desmet, S. D.*

Given a circle with centre, O, the point P, and a line MN. To construct a circle having its centre on MN, passing through P, and tangent to the given circle.

404. *Proposed by C. E. Jenkins, Indianapolis, Ind.*

In the triedral angle X—ABC, XD is the bisector of the face angle BXC.

Prove: $\angle AXD \gtreqless \frac{1}{2}(\angle AXB+\angle AXC)$ according as $\angle AXD$ is acute, right or obtuse. (From Sander's Geometry.)

Trigonometry.

405. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If $\cos A+2\cos C : \cos A+2\cos B = \sin B : \sin C$, what is the nature of the triangle?

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

Answer serially numbered problems in the following lists:

HARVARD PHYSICS.

New Plan—One Hour and a Half—Omit Four Questions.

161. A diamond ring weighs 4.00 grams in air and 3.72 grams in water. Find the weight of the diamond if the specific gravity of gold is 17.5 and that of diamond is 3.5.

2. (a) Define *surface tension.*

(b) Explain the apparent attraction of two small floating bodies for each other if they are wet by the liquid in which they float.

3. Two men, A and B, 12 feet apart, carry a 150 pound weight between them on a pole. Where must the weight be placed in order that A may not carry more than 60 pounds? Give a diagram.

4. (a) Explain the difference between *work* and *power.*

(b) A steam pump fills a tank with water in 4 hours. The capacity of the tank is 5,000 gallons, and the elevation of its centre of gravity is 40 feet. If a gallon of water weighs 8 pounds, what is the total work done and what is the horse-power of the pump?

5. At what temperature does a Fahrenheit thermometer read twice as much as a Centigrade thermometer? State whether the answer given is expressed on the Centigrade or on the Fahrenheit scale.

162. If a silver spoon weighing 30 grams be put into a cup weighing 80 grams which contains 180 grams of coffee at 80° C., how much will the coffee be cooled?

Specific heat of the coffee = 1.0.
Specific heat of silver = 0.056.
Specific heat of the cup = 0.20.
Initial temperature of the spoon = 15° C.

7. The vertical walls of a canyon are parallel and a mile apart. A man in the canyon fires a gun and hears the first two echoes, one from each wall, 4 seconds apart. Where is he?

Velocity of sound = 1100 feet per second.

163. If a photographic print can be made in 30 seconds when held 3 feet from a 32 candle-power lamp, how long will it take at a distance of 2 feet from a 16 candle-power lamp?

9. Where must an object be placed in relation to a simple convex lens of 10 centimeter focal length,

(a) to give a *real* image of twice the dimensions of the object?

(b) to give a *virtual* image of twice the dimensions of the object?

(c) What are the defects of a simple lens?

10. Explain the difference in principle and use between a gold leaf electroscope and a galvanometer. How does a voltaic cell differ in action from a charged Leyden jar?

11. (a) What is your conception of the meaning of the terms "volt" and "ampere?"

(b) What is the resistance of a 40 watt lamp that is operating on a 110 volt circuit?

12. If a certain type of electrical heating coil takes 500 watts from a 100 volt line, how many watts will two such heaters take from the same line,

(a) if connected in series?

(b) if connected in parallel?

PHYSICS—College Entrance Examination Board, June, 1914.

GROUP A. (OMIT ONE QUESTION FROM THIS GROUP.)

1. Why is it easier to roll a barrel up a long board into a wagon than to lift it vertically?

How does the work done against gravity when the barrel is rolled up the board compare in amount with the work required to lift it vertically?

164. At what depth in a lake will a bubble of air have one-half the volume that it has on reaching the surface when the barometric height at the surface is 73 centimeters? (The density of mercury is 13.6.)

3. A 5-lb. weight is hung from one end of a uniform bar of wood 4 feet long and weighing 6 lbs. At what point must the bar be supported to balance in a horizontal position?

4. A ball is thrown up and 5 seconds later is caught.

(a) How high did it rise?

(b) With what velocity did it return to the hand?

GROUP B. (OMIT ONE QUESTION FROM THIS GROUP.)

5. Describe an experiment, preferably one which you have personally performed, by which the pitch of a musical tone may be determined.

6. An observer sets his watch by the report of a signal gun one mile away. Find, to one-tenth of a second, the allowance that he should make on account of the distance of the gun, the temperature of the air being 20° C.

GROUP C. (OMIT ONE QUESTION FROM THIS GROUP.)

7. Explain the construction and operation of some form of refrigerating apparatus as used for making artificial ice or for cooling rooms.

8. What is meant by the specific heat of a substance?

A piece of nickel weighing 200 grams at temperature 98° C. was dropped into 500 grams of water at temperature 18° C. The resulting temperature was 21.4° C. Find the specific heat of nickel.

9. The volume of a body of gas at 27° C. is 100 cubic centimeters. If the pressure on the gas is doubled to what temperature must it be heated in order to maintain the volume constant?

GROUP D. (OMIT ONE QUESTION FROM THIS GROUP.)

10. How is the bending of a ray of light passing from air into water explained by the wave theory of light? Illustrate by means of a diagram.

11. Describe a method by which the velocity of light has been determined. The distance from the earth to the sun is approximately 93,000,000 miles. How long a time is required for light to traverse this distance?

165. At what distance from a 40-candle-power mantle burner would a newspaper receive the same illumination as it would receive from an 8-candle-power incandescent lamp 2 feet distant from it?

GROUP E. (OMIT ONE QUESTION FROM THIS GROUP.)

13. How does a charge of electricity distribute itself on an insulated conducting body such as a metal pail or cup? How is the distribution tested experimentally?

166. An electric motor, found, by a brake test, to develop 2 horse-power, requires 8.25 amperes at an electromotive force of 220 volts. What is the efficiency of the motor, expressed in per cent?

15. A galvanometer has a resistance of 171 ohms. With what resistance should it be shunted in order that only one-tenth of the current in the main circuit may pass through it?

SOLUTIONS AND ANSWERS.

137. *Proposed by Theodore Cohen, Brooklyn, N. Y.*

Manganese dioxide is allowed to react with a solution of hydrochloric acid. How would you teach this to a class as an oxidation = reduction reaction in electrical terms?

Solution by P. K. Shah and C. M. Jhaveri, Boy's High School, Sojitra, India.

The ordinary equation which represents the reaction is

$$MnO_2+4HCl\rightarrow MnCl_2+2H_2O+Cl_2.$$

In electrical terms, this equation will stand

$$Mn^{\cdots\cdot}\,O_2''+4H^{\cdot}\,Cl'\rightarrow Mn^{\cdot\cdot}\,Cl_2'+2H_2^{\cdot}\,O''+Cl_2^{\cdot\cdot}.$$

Thus, the Mn-ion which had four *positive* charges, loses *two* during the reaction, i. e., $Mn^{\cdots\cdot}$ is reduced to $Mn^{\cdot\cdot}$. The two positive charges thus liberated react upon two Cl-ions which have one negative charge each, making the two Cl-ions neutral; hence Cl_2 (molecule of chlorine) becomes nascent; i. e., Cl_2' is oxidized to Cl_2 (gas).

It is needless to add that the other two Cl-ions (with one negative charge each) undergo no change except that of changing partners (from H to Mn). The same is the case with H-ions (positive) and O-ions (negative).

141. *Also solved by Benjamin Bennes, Newark, N. J., and P. K. Shah and C. M. Jhaveri, Sojitra, India.*

142. *Proposed by Harry Roeser, Stillwater, Okla.*

A person stands directly in front of the vertical middle line of a square post, throws a slip noose over it and draws the line taut. It is a fact that the rope can not be made to fit the post snugly. What will be the angle between the rope and the post?

An objection by Harry Roeser to the solution as published in the June issue:

The author of that solution evidently obtained it by assuming that the stresses in the three branches of the rope were equal and applying the well known conditions for equilibrium.

Suppose that before the noose reached its limiting position that it was knotted so it could slip no farther and so that the angle between the rope and the post was say 45°.

Then calculate the components of the forces in BC and BA in the direction DB. Then according to the author's assumption

$$T \sin 45 = .7071 = \text{comp CB} = \text{comp AB}.$$

Then if the force in BD, as the author claims, is T, we have a force T held in equilibrium by a force 1.4142 T a condition which I feel pretty safe in saying occurs somewhat rarely in nature.

It is true that in the limiting position that the rope makes an angle of 30° with the post and the stresses in all three branches of the rope are equal. This last condition only occurs, however, in a structure or frame-

work when the three concurrent members make angles of 120° with each other. This of course, for our case, means that the rope makes an angle of 30° with the post.

Therefore if we take this last condition for granted we are using a corollary to the problem to solve the problem itself. In other words the proposed solution is no solution at all.

143. *Proposed by R. C. Colwell, Beaver Falls, Pa.*

A body is projected upward with any velocity and t, t_1 denote the times in which it is respectively above and below the middle point of its path. Find the value of t/t_1. (Williamson, Particle Dynamics, P. 37).

Solution by R. T. McGregor, Coleville, Cal.

Let v denote the velocity of the body. Then the time of ascent $= \frac{v}{g}$, and the height to which the body rises $= \frac{v^2}{2g}$. The distance of the midpoint of its path from the starting point $= \frac{v^2}{4g}$. The time of ascent from the midpoint of its path to the point of maximum ascent $= \frac{v}{g\sqrt{2}}$. The whole time which it is above the midpoint $= \frac{2v}{g\sqrt{2}} = t$. The time required to ascend the first half of its path $= \frac{v}{g}\left(1-\frac{1}{\sqrt{2}}\right)$. The whole time which it is below the midpoint $= \frac{2v}{g}\left(1-\frac{1}{\sqrt{2}}\right) = t_1$.

Hence $\frac{t}{t_1} = 1+\sqrt{2}$.

Also solved by H. C. McMillin, Washington, Kans., and W. C. Phebus, Lorain, Ohio.

146. [*From a Regents' (N. Y. State Education Dept.) examination.*] Carbon dioxide contains 27.27 per cent of carbon and 72.73 per cent of oxygen, and carbon monoxide contains 42.86 per cent of carbon and 57.14 per cent of oxygen. Show how the composition of these compounds illustrate the law of multiple proportions.

Solution by P. K. Shah and C. M. Jhaveri, Sojitra, India.

Let us take a definite weight of carbon in both CO_2 and CO.

Taking 27.27 gms. in both the weight of oxygen in CO_2 is 72.73 gms.

Now, as regards the weight of oxygen in CO, we have

42.86 gms. C : 27.27 gms. C. : : 57.14 gms. O : x gms. O

$$x = 36.35 \text{ gms.}$$

Now 36.35 is approximately $\frac{1}{2}$ of 72.73. Thus, for the same weight of carbon, we require double the weight of oxygen for CO_2 of that required for CO.

Thus the Law of Multiple Proportions is exemplified in this case.

Again, taking 42.86 gms. as the definite weight of carbon, we have (as regards the weight of O in CO_2)

27.27 gms. C : 42.86 gms. C : : 72.73 gms. O : x gms. O.

$$x = 114.29.$$

Now 114.29 is double 57.14.

Hence a double weight of O is required for CO_2 of that required for CO. Thus the Law of Multiple Proportions is exemplified, viz., when two elements combine to form more than one compound, the higher weights of

one element for a definite weight of another are simple multiples of the lowest weight required.

(The second case is given, as it gives a more exact result.)

147. *(From a Regents' examination.)* What is the chief chemical difference between a baked potato and a boiled potato? Why does this difference exist?

No *solutions* for this question have been received though a number of correspondents have very pointedly asked—"Who does *know* the chemical difference?" Evidently, it is a general opinion that such a question is an improper one to ask on an examination.

148. *Proposed by Harry Roeser, Oklahoma Agr. & Mech. College, Stillwater, Okla.*

Some trouble is experienced in railroading on account of the rails "creeping." If a heavy train is running west do the rails have a tendency to "creep" towards the west or east? Why?

On some temporary track on Euclid Ave., Cleveland, sand piled between the cross braces clearly showed a "creep" *in the direction* in which the cars were traveling. It is the Editor's opinion, however, that this thrust was caused by the bump given the track when the cars mounted the cross-over.

149. *Proposed by W. A. Tippie, Troy, Ohio.*

A pendulum which beats seconds accurately at a place where the value of g is 980.9424 is transferred to a place where g is 980.3161. How will its time compare with the true time at the end of a day?

Solution by J. O. Perrine, Iowa State Teachers College, Cedar Falls, Iowa.

If one writes the formula for the pendulum as follows $\frac{T}{n} = \pi\sqrt{\frac{l}{g}}$ and then uses calculus, the solution of the problem is at once apparent. In this formula T is the total time considered and n, the number of single vibrations in that time. Hence $T = 86{,}400$ and $n = 86{,}400$.

Taking derivative of n with respect to g and passing to differentials the result is as follows:

$$\frac{dn}{n} = \tfrac{1}{2}\frac{dg}{g}$$

This may be written as follows and results will be correct to a close approximation.

$$\frac{\Delta n}{n} = \tfrac{1}{2}\frac{\Delta g}{g}$$

$$\Delta n = \frac{n}{2} \cdot \frac{\Delta g}{g} = \frac{86{,}400}{2} \cdot \frac{.6263}{980.9424}$$

$$\Delta n = 27.58 \text{ seconds.}$$

Clock would be 27.58 seconds slow at end of a day.

Also solved by H. C. Trimble, Bradley Polytechnic Institute, Peoria, Ill.
(Answer, 24.19 seconds.)

ARTICLES IN CURRENT PERIODICALS.

American Botanist for May; *Joliet, Ill.; $1.00 per year, 25 cents a copy:* "The Beech Ferns," Willard N. Clute; "The Mints," Adella Prescott; "Nature's Vacation," W. W. Bailey; "Spraying to Kill Weeds, Mushrooms and Toadstools"; "Palestine Fruits in California Gardens."

American Forestry for June; *Washington, D. C.; $2.00 per year, 20 cents a copy:* "An Epitome of National Reclamation" (6 illustrations), C. J. Blanchard; "Street Tree Planting in a Western Town" (1 illustration), W. W. Robbins; "Our Mountain Meadows" (6 illustrations), Harold C. Bradley; "Chestnut Blight Continues" (1 illustration), Oliver D. Shock; "Conservation for Lumbermen"; "George W. Vanderbilt, Pioneer in Forestry" (4 illustrations), Overton Westfeldt Price; "Pisgah Forest Purchased" (3 illustrations); "Drift Fences for Stock" (2 illustrations); "Half of Each Tree Lost" (3 illustrations).

American Journal of Botany for June; *Brooklyn Botanic Garden, Brooklyn, N. Y.; $4.00 per year, 50 cents a copy:* "The Harmful Action of Distilled Water," Rodney H. True; "Some Observations on the Formation of the Capillitium and the Development of Physarella Mirabilis Peck and Stemonitis Fusca Roth," Guy R. Bisby; "New Species of Green Algae," Edgar Nelson Transeau.

American Mathematical Monthly for June; *5548 Kenwood Ave., Chicago, Ill.; $2.00 per year:* "The Construction of Conics under Given Conditions," B. M. Woods; "A Simple Method of Constructing the Normals to a Parabola," S. G. Barton; "Some Properties of the Normals to a Parabola," S. G. Barton; "A Simple Algebraic Paradox," J. L. Coolidge; "On a Purely Projective Basis for the Theory of Involution," D. N. Lehmer.

American Naturalist for July; *Garrison, N. Y.; $4.00 per year, 40 cents a copy:* "Pattern Development in Mammals and Birds," Glover M. Allen; "Internal Relations of Terrestrial Associations," Arthur G. Vestal; "Shorter Articles and Discussion: Another Hypothesis to Account for Dr. Swingle's Experiments with Citrus," A. C. and A. L. Hagedoorn.

Educational Psychology for June; *Warwick and York, Baltimore, Md.; $2.50 per year, 30 cents a copy:* "A Child's Progress in Speech, with Detailed Vocabularies," W. G. Bateman; "The Effect of Practice Upon Visual Apprehension in School Children. Part I," Karl M. Dallenbach; "The Binet-Simon Measuring Scale for Intelligence: An Annotated Bibliography. Part III," Samuel C. Kohs.

L'Enseignement Mathématique for May; *Stechert & Co., West 25th Street, New York; 15 francs per year, 3 francs per copy;* Compte rendu de la Conférence internationale de l'Enseignement Mathématique, Paris 1-4 avril 1914, publié par H. Fehr, secrétaire général de la Commission.

Journal of Geography for June; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "The Problem of Place Geography," Douglas C. Ridgley; "Vienna," Charles A. McMurry; "What Shall School Geography Include?"; "The Question of Field Work in Geography," Walter S. Tower; "The Subject Matter for an Elementary Course in Economic and Commercial Geography," Mary J. Lanier.

Journal of Home Economics for June; *Roland Park Branch, Baltimore, Md.; $2.00 per year, 50 cents a copy:* "The Training of the School Dietitian," Caroline L. Hunt; "The Administration of School Lunches in Cities," Alice Boughton; "Household Science in Secondary Schools," Florence and Meriel Willard; "Pure Textiles," L. H. Dewey; "The Relation of House Planning to Home Economics," Helen Binkerd Young; "Present Tendencies in Household Arts Teaching," Helen Kinne; "Some Recent Experiments in the Teaching of Foods and Sanitation," Cora M. Winchell; "The Equipment of the Washington Irving High School," Edythe M. Pownall; "Health Hints for Summer," H. W. Hill; "The Need of Trained Assistants in the Home," Mary V. Shailer; "Home Canning," Grace E. Stevens.

Mathematical Gazette for May; *G. Bell & Sons, Portugal Street, Kingsway, London, six nos., 9s. per year, 2s. 6d. per copy:* "Desargues' Theorem," Major E. T. Dixon; "The Calculus as an Item in School Mathematics

(Concluded)," C. S. Jackson; "The Teaching of Easy Calculus to Boys (Concluded)," W. Knowles; "The Anharmonic Ratio of Four Points in Space and the Discord of two Pairs of Points," R. F. Muirhead; "A First Chapter on Elliptic Functions," Prof. E. B. Elliott. For July: "Newton," An outline of his life and what he did, by W. W. Rouse Ball.

Physical Review for July; *Ithaca, N. Y.; $6.00 per year, 50 cents a copy:* "On the Growth and Decay of Color Sensations in Flicker Photometry," M. Luckiesh; "The Maintenance of Vibrations," C. V. Raman; "The Luminescence of Kunzite," E. L. Nichols and H. L. Howes; "Note on the Relation between the Emission of Spectrum of a Compound and Its Absorption Spectrum in Solution," Albert K. Chapman; "Some Brush Discharge Phenomena Produced by Continuous Potentials," Stanley P. Farwell; "The Reproduction and Measurement of Very Short Intervals of Time," John Coulson; "Note on Evidence for Electron Atmosphere," F. F. Householder; "Wave-Length-Sensibility Curves for Light Sensitive Selenium and their Significance," F. C. Brown and L. L. Sieg; "High Temperature Measurements with the Stefan-Boltzman Law," C. E. Mendenhall and W. E. Forsythe.

Popular Astronomy for June-July; *Northfield, Minn.; $3.00 per year, 25 cents a copy:* "Relations between the Spectra and Other Characteristics of the Stars" (Continued), Henry N. Russell; "Registering Instruments Employed in the Meridian Service at the Observatory of Paris, with Plates XVI, XVII, XVIII, XIX," Professor W. Simonin.

Popular Science Monthly for July; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "Man and the Microbe," Professor C. E. A. Winslow; "Facts and Factors of Development," Professor Edwin Conklin; "Waste in Elementary and Secondary Education," Principal Franklin W. Johnson; "The Struggle for Equality in the United States," Professor Charles F. Emerick; "Genesis and Revelations of the Yosemite Valley," Harold French; "Graphics of the American Whaling Industry," Dr. J. Arthur Harris; "The Bad Habit of Having Law Makers and Lawyers," John C. Dana; "How We Defend Ourselves from Our Foes," Professor Fraser Harris.

Psychological Clinic for June; *Woodland Ave. and 36th St., Philadelphia, Pa.; $1.50 per year, 20 cents a copy:* "The Problem of Life from a Girl's Point of View," Margaret Otis, Resident Psychologist, State Home for Girls, Trenton, N. J.; "A Study of the School Inquiry Report on Ungraded Classes," Elizabeth E. Farrell, Inspector of Ungraded Classes, New York City (Concluded); "The Further History of Some Troublesome Boys," Horace Barnes.

School World for July; *Macmillan and Company, London, Eng.; 7s. 6d. per year, 6 pence a copy:* "Applied Chemistry in a School Course," W. A. Whitton; "Multiplication and Division of Decimals," R. C. Fawdry; "The Relation of 'Drawing' to Other School Subjects," E. M. Carter; "The Kinematograph in Education."

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 3; Otto Salle, Elssholzstr. 15, Berlin W. 57, Germany; M. 4. per year, 60 Bf. per copy: "Die Brille im Unterricht," Dr. W. Hillers; "Zur Gleichung 3. Grades," Karl Siemon; "Verstand und Gedächtnis im geometrischen Unterricht," Dr. W. Dieck; "Ableitung der Additionstheoreme für sin a und cos a," Direktor Prof. Dr. Friedr. Fricke. Nr. 4: "Mathematik und Philosophie," Schulart Prof. Dr. Alex. Wernicke; "Die Luftelektrizität im Unterricht," Prof. Dr. h. c. Geitel.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht Aller Schulgattungen for May; *B. G. Teubner, Leipzig, Germany; 12 numbers, M. 12. per year*: "Was ist 'angewandte Mathematik'?" Geh. Regierungsrat Prof. Dr. C. Runge; "Zur Lehre von der dreiseitigen Ecke," Geh. Regierungsrat Prof. Dr. Rudolf Sturm; "Der Wert der geschichtlichen Methode in physikalischen Unterricht," Prof. Dr. Artur Erich Haas; "Ueber Die Ausführung der planimetrischen Grundaufgaben," Oberl. Albert Rohrberg; "Zur Medthode des Quadratwurzelausziehens," L. Wulff. 6 Heft, 29 Mai: "Masse und Stoffrmenge," Prof. Dr. K. Schreber; "Der mathematische Unterricht in Japan," Oberl. Dr. Georg Wolff; "Wünschenswerte Einheitlichkeit in der Benennung grösster Kreise der Himmelskugel," Chr. Lenhardt; "Zur Belebung des Unterrichtes in der

Stereometrie," A. Witting; "Der Rechenschieber 'System Cuntz'," Jakobi. 4. (Doppel=) Heft, 6 Juli: "Aus dem Unterricht in der Geometrie der Lage," Direktor Prof. Dr. Hans Keferstein; "Zur Frage des Unterrichts in der neueren Geometrie," Oberl. Dr. Max Zacharias; "Zur Frage nach der Bedeutung der projektiven Geometrie für den mathematischen chulunterricht," Direktor Dr. P. Zühlke; "Zur Umbildung der euklidischen Geometrie," Prof. Rudolf Böger; "Die trigonometrischen Summenformeln," Prof. Rudolf Böger; "Der Satz vom Umfangswinkel," Prof. Rudolf Böger; "Der Geist der neueren Geometrie," Oberl. Dr. W. Dieck.

Zeitschrift für den Physikalischen und Chemischen Unterricht for May; *Prof. Dr. F. Paske, Berlin-Dohlem, Friedbergstrasse 5; 6 numbers, $2.88, M12 per year:* "Eine neue Demonstrations-Apparatur für kurze elektrische Wellen," G. Leimbach; "Verwendung des photographischen Apparates zu Aufnahmen bewegter Körper im Lichte der Wechselstrombogenlampe," R. Danneberg; "Ein Versuch über die Abhängigkeit der Schwingungszeit eines Fadenpendels von der darauf wirkenden Kraft," K. Roland; "Die Bestimmung von C_p/C_v im Mittelschulunterricht," L. Nagele; "Versuche zur Ermittelung der chemischen Zusammensetzung des Ammoniaks," G. Gruber; "Die Chlorentwicklung mittels Kaliumpermanganats nebst Vereinfachungen und Ergänzungen zu den Chlorversuchen, insbesondere mit Metallwollen," O. Ohmann; "Tafelwage und Zeigerwage," O. Praetorius; "Zur Verwendung von Isolierband (Lassoband)," H. Rebenstorff; "Ein Drehspulgalvanometer für Selbstanfertigung," C. Asmus; "F. Zander, Abänderung des Foucaultschen Interruptors.—Modell einer Differentialbogenlampe," Für die Praxis.

LIVE CHEMISTRY.

By H. R. Smith,

Lake View High School, Chicago.

In imparting knowledge to students, teachers unconsciously tend to emphasize the subject matter and neglect methods of presentation. Educators are generally agreed that subject matter is less important than the mental training given and the habits of mind formed. If a careful inventory is taken of the value of the mental training received by high school students there will be few teachers who are enthusiastic over their successes. Now, the fact that students retain so little of the subject matter implies a weakness in method. Young people like adults permanently remember those facts which come to mind in some unusual way or those which are in some way related to present interests. Teachers can hope to impress facts on the minds of students in the first way but occasionally; the latter must be the one generally used. Many of our science texts endeavor to arouse interest by making applications after the presentation of a principle. After a forced bitter dose it may soothe the student mind to know the value of the dose; but he will not be enthusiastic. We ask, "Why not reverse the treatment?" Discuss uses and values first. Give the student the dignity of a co-worker. With a *live* purpose in mind all students will undertake rigorous work with enthusiasm.

But this idea is not easy to execute. The teacher must do much thinking and planning. We are striving for an ideal that is worth while. If more teachers will work out experiments we shall approach this ideal more rapidly. Below we offer experiments which will mordant the principle of "oxidation and reduction" in the student mind so that he shall not easily forget it. He will receive good training in scientific method also. This method of approach to the experiment "Detection of Sulphur Dioxide" is urged:—Insist that each student bring some suitable food product from

home for the test. In a few minutes the instructor can explain the use and purpose of Sulphur dioxid in preparing certain food products for market. (See Bull. No. 84, Part III, U. S. Dept. of Agr.) The teacher's explanation enables the student to choose the proper materials to bring and also starts him thinking about the proposed experiments. In case the tests are doubtful or negative a small amount of sodium sulphite is added and the tests repeated. The student will then have sufficient data for making correct conclusions. In the recitation and final record of the experiment the instructor makes clear the real object of the experiment, the knowledge of the principle of oxidation and reduction. The student should understand that it is through this knowledge that he obtains his object, the knowledge of the presence or absence of sulphite in the food which he eats. Because of his interest the student does much more thorough work.

A more simple case of oxidation and reduction can be presented in the experiment on "Solvent Action of Fruit Acids" which follows. We suggest that a portion of the class use aluminum in the tests while others use copper, so the comparative results may be had. If tarnished copper is used the loss in weight of the metal will be found to be greater due to the greater action of these acids on copper oxid and carbonate.

DETECTION OF SULPHUR DIOXIDE.

By Thos. R. Moyle,
Stout Institute, Menomonee, Wis.

It is very easy to find food material containing sulphur dioxide. In the case of dried fruits it is used both for its preservative power and for bleaching; in meats it takes away the odors of incipient decomposition, restores the fresh color, and stops further decomposition. It is an excellent adulterant—from the standpoint of the adulterator. The fact, attested by government experts, that it is harmful is not of sufficient weight to be allowed to interfere with its use. Dried apples, pears, apricots and figs contain it. It should be emphasized that the fair, white, evaporated apple of the present day is no more wholesome than its attic-dried, dust-covered and fly-specked predecessor. Sodium sulphite is to be looked for in sausage and in Hamburg steak during the hot weather, especially if it remains suspiciously fresh after exposure to the air. There are two methods whereby we can test for sulphur dioxide, one by oxidizing it and the other by reducing it, so that this experiment furnishes examples of these processes as well as a method for the detection of a common food adulterant. This experiment is hopefully proposed as a blending of "busy work" and real science.

(a) Reduction method: Put about 50 g. of the food material in a 250 cc. flask and add enough water to cover it. Put into the flask about 15 g. of granulated zinc and enough hydrochloric acid to secure a brisk evolution of hydrogen. Put over the mouth of the flask a piece of filter paper moistened in a solution of lead acetate. Warm the flask and a decided brown or black stain will appear on the filter paper if the food material has been sulphured.

Fruits are sulphured by exposing them to the fumes of burning sulphur. Meats are treated with a sulphite. Write out the reactions which will account for the brown stain and will show that sulphur is reduced both in the sense that oxygen is taken away from it and that its valence is reduced from 4 to 2.

(b) Oxidation method: Put 50 g. of the food material in a similar

flask to that used in (a), cover with water and add 20 cc. of hydrogen peroxide solution, shake and filter. If upon adding a solution of barium chloride a heavy white precipitate appears which is insoluble in an excess of hydrochloric acid you have a test for sulphur dioxide. Show by equation how the precipitate is obtained and how this is an example of oxidation.

A trace should be disregarded in both of these tests. It is better to use distilled water.

SOLVENT ACTION OF FRUIT ACIDS.

By Roy E. Bowman,
Alliance High School, Ohio.

Cleanse a piece of copper gauze 1″ square, by heating to just red heat in burner flame and then dipping, while hot, in wood alcohol. Care is needed to prevent fusion of gauze by too great heat. Rinse and dry in such a way as not to reoxidize the copper, then weigh to centigrams. Make up solutions, 2.5 gms. each in 100 cc. of water; acetic (glacial), oxalic, citric, tartaric acids and sodium carbonate. Bring each solution to a boil, place the metal in it and boil 10 minutes. Rinse with distilled water, dry and re-weigh. Compute loss of metal in each case. What would you say as to the relative safety of copper and aluminum ware for household use, especially the canning of acid fruits? What compound is formed when the oxidized copper is dipped into the wood alcohol? (equation).

One bath can be brought to a boil while the copper is being dried and weighed after the previous bath.

ABOUT YOUR DICTIONARY.

At school a dictionary is considered an essential and is always at hand. For best results in home work it should be equally accessible at home. There is no surer test of one's intelligence than the ability to express what one knows clearly, forcefully, and with some degree of elegance. The mastery of English is essential to him who would be the leader among his fellows, or their most helpful servant.

The New International (G. & C. Merriam Co., Springfield, Mass.,) is really an all-knowing special teacher whose services are always available. See display advertisement elsewhere in this issue.

MEMORANDUM FOR MATHEMATICS TEACHERS.

The Council of Mathematical Teachers in New England has recently appointed a special committee on the status and welfare of mathematics in secondary schools, to investigate and report on current criticisms of high school mathematics. The membership of the committee is as follows: Mr. G. W. Evans, Charlestown High School; Professor F. C. Ferry, Williams College; Mr. A. V. Galbraith, Middlesex School; Mr. F. P. Morse, Revere High School; Mr. C. D. Meserve, Newton High School; Professor S. E. Smith, Mount Holyoke College; Miss H. R. Pierce, Worcester High School; and Professor H. W. Tyler, Massachusetts Institute of Technology, chairman.

Correspondence with persons having special information is invited.

June 9, 1914.

THE ANNUAL MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The fourteenth annual meeting of the Central Association of Science and Mathematics Teachers will be held at Chicago in the magnificent new building of the Hyde Park High School, November 27th and 28th, the Friday and Saturday after Thanksgiving.

Plans for the meeting are practically completed. These will provide one of the most helpful and timely programs ever presented by the Central Association. The pronounced success of the practical program of last year, which had as its central theme "Vocational Courses in Science and Mathematics," has been an incentive to those who have planned the coming program. The consideration of this theme is continued as a part of the general topic for the next meeting, *"Problems Arising in Adjusting Applied Science to High School Curricula."*

The fundamental importance of properly applying the science and mathematics taught in our high schools is realized today as never before by progressive teachers. The place and purpose in high school curricula of courses in agriculture, domestic science, and vocational subjects are matters not clear as yet in the minds of many teachers and others interested in education. These subjects will be discussed both in the general sessions and in the section meetings by many of the ablest and most prominent teachers of the country.

Dean Eugene Davenport of the University of Illinois, known throughout our country and abroad through his books on Agricultural Education and his constructive, forceful, and interesting addresses on educational topics, will give an address at the general session on November 27th on "Vocational Education." Miss Van Ranssalear, Head of the Department of Home Economics of Cornell University, Ithaca, New York, will address the Association at the same session upon the place and purpose in our schools, of courses in Domestic Science and Household Arts. Miss Van Renssalear's address will be of interest and value to every member of the Central Association. It should be heard by every live teacher in the Central states.

Agriculture and Domestic Science are given a prominent place on the programs of the next meeting, not only because they are well worth considering, but especially in recognition of the formation of two new sections in the Central Association. In accordance with action taken at the Des Moines meeting last fall strong committees of enthusiastic teachers in these subjects have been at work since early in the year, arranging programs of unusual interest and value to educators and teachers interested in these subjects.

Professor A. W. Nolan of the University of Illinois is chairman of the program committee for Agriculture, while that for Domestic Science is headed by Miss Minna C. Denton, Head of the Department of Home Economics of the Ohio State University.

Each of the five original sections of the Central Association, Biology, Chemistry, Earth Science, Mathematics, and Physics has had a strong program prepared for it by the officers elected at the Des Moines Meeting. The addresses and discussions of the several sessions will appear in the *Proceedings* of the meeting, to be issued after the close of the meeting.

An unusual effort is being made at this time to make the coming meeting of the Central Association, the largest and most influential in its history. Every teacher of science and mathematics in the Central States should begin to plan now to attend the Central Association Meeting, November 27th and 28th.

For programs and additional information write the Secretary, Mr. W. L. Eikenberry, University High School, University of Chicago.

THANKSGIVING MEETING OF HOME ECONOMICS TEACHERS.

A meeting of high school home economics teachers is to be held in Chicago at Hyde Park High School, November 27 and 28, 1914. The Central Association of Science and Mathematics Teachers, a well-known organization of college and high school teachers, has recently established a section for us. Although detailed statements as to program cannot be given at this date, the following announcements, can be definitely made:

The general subject of the meeting is, Development of Applied Science in High School Teaching, and papers are to be presented in chemistry, physics, and other sections which will be of interest to home economics teachers.

The general meeting for all sections occurs Friday morning, November 27th; one of the features of this program is an address by Miss Martha Van Rennselaer of Cornell University on The Place of Home Economics in Secondary Education.

Friday afternoon occurs the round table for the home economics section. One of the subjects to be discussed is housekeeping courses; Miss Bernice Allen of the School of Education, University of Chicago, and Miss Agnes Wilson, teacher of Chicago Stockyards Housekeeping Center, will lead in this discussion.

Saturday morning the subject, Mutual Relations to be Established between Home and Home Economics Classroom, is to be presented by Mrs. Wm. S. Hefferan of Chicago, who speaks for the interested mother; and School Credit for Home Work will be discussed by a teacher who has had successful experience in securing such work. A talk will be given by Miss Agnes Hanna, School of Education, University of Chicago, on Suggestions for Teaching Drafting of Dress Patterns in High School.

An excellent series of moving picture films to illustrate textile manufacturing processes, presented under the auspices of Marshall Field and Company firm, is promised us for Saturday afternoon.

Other features of these section meetings will be: An exhibit of notebooks, to which all are cordially invited to contribute; an exhibit of textbooks and other literature, charts, illustrative material; an exhibition of up-to-date household appliances. Also we are to discuss the question of the establishment of a journal for high school teachers of home economics, or what is more probable, of a department for them in some already established journal.

Further announcements will appear in November and December numbers of this Journal, which is the official organ of C. A. S. and M. T. Will you not lend us your presence, your interest and suggestions, the support of your membership?

Committee on organization:

MINNA C. DENTON, *Ohio State University.*
JENNY H. SNOW, *Chicago Normal College.*
BERNICE ALLEN, *University of Chicago.*
MILDRED WEIGLEY, *De Kalb Normal.*
JULIA TEAR, *Hyde Park High School, Chicago.*
MRS. HUBBELL, *Englewood High School, Chicago.*

BOOKS RECEIVED.

First Book of Zoölogy, by T. H. Burlend, University College of South Wales. 159 pages. 12x18 cm. Cloth. 1913. 50 cents.

How Man Conquered Nature, by Minnie J. Reynolds. Pages v+249. 12x18 cm. Cloth. 1914. 40 cents. Macmillan Company, New York.

The Natural History of the Farm, by James G. Needham, Cornell University. 348 pages. 14x20 cm. Cloth. 1913. The Comstock Pub. Co., Ithaca, New York.

Africa, a Supplementary Geography, by James F. Chamberlain, Normal School, Los Angeles, Cal. Pages vi+210. 13x19 cm. Cloth. 1914. 55 cents.

Physics of the Household, by Carleton J. Lynde, Macdonald College, Canada. Pages xi+313. 14x20 cm. Cloth. 1914. Macmillan Company, New York.

Mathematics for Freshman Students of Engineering, by Theodore Lindquist, Lombard College. Pages ix+135. 16x25 cm. Cloth. 1911. University of Chicago Press.

A School Course in Geometry, by W. J. Dobbs. Pages xxii+427. 12.5x19 cm. Cloth. 1913. $1.00.

The Groundwork of Arithmetic, by Margaret Pannett, University of London. Pages xi+234. 12.5x19 cm. Cloth. 1914. $1.00.

Slide-Pole Notes, by Colonel H. C. Dunlop and C. S. Jackson. 127 pages. 12.5x19 cm. Cloth. 1913. 75 cents. Longmans, Green & Co., New York.

Chemistry, by George Darzens, École Polytechnique, Paris. Pages viii+122. 13x19 cm. Cloth. 1914.

Thresholds of Science, by C. A. Laisant, Associate Editor of this Journal. Pages viii+156. 13x19 cm. Cloth. 1914. Doubleday, Page & Company, New York.

Outline of Science for the Four Upper Grades, by Percy E. Powell, Berkeley, Cal. 52 pages. 12x16 cm. Paper. 1913. 25 cents. Published by author.

Pflanzenanatomie, Nach der Fünften Russischen Auflage Übersetzt und Bearbeitel, von Dr. S. Tschulok, Privatdozent an der Universität Zürich. Pages iv+195. 16x25 cm. mit 174 Abbildungen im Text. Paper. 1914. Geb. in Leinwand M5.— B. G. Teubner in Leipzig.

Der Bou der Weltalls von Prof. Dr. T. Scheiner. Vierte Auflage, mit 26 figuren im Text. 132 pages. 12x18 cm. Cloth. 1914. B. G. Teubner, Leipzig.

Anatomy and Physiology, by Elizabeth R. Bundy, M. D. Third edition revised and enlarged with a glossary and 233 illustrations 43 of which are printed in colors. Pages xv+408. 16x24 cm. Cloth. 1914. $1.75. Net postpaid. P. Blakiston's Son & Co., Philadelphia.

Der Kalender in gemernveuländlicher Darstellung von Prof. Dr. Walter F. Wislicenus. 118 pages. Cloth. 1914.

Allgemeine Geologie III Die Arbeit des fliessenden Waness. Von Dr. Fritz Frech, University of Breslau. 122 pages. Cloth. 1914. B. G. Teubner, Leipzig.

Dialogues concerning Two New Sciences by Galileo Galilei. Translated from the Italian and Latin into English by Henry Crew and Alfonso De Salvio of Northwestern University. Pages xxv+300. 19x23.5 cm. Heavy board c'oth back. 1914. $2.00. The Macmillan Company, New York.

School Arithmetic Primary Book, by Florian Cajori, Colorado College. Pages ix+283. 12.5×19 cm. Cloth. 1914. 35 cents. The Macmillan Company, New York.

The Tangible Rewards of Teaching, compiled by James C. Boykin and Roberta King. 465 pages. 14.5x22 cm. Paper. 1914. Government Printing Office, Washington, D. C.

Elementary Household Chemistry, for Students of Home Economics, by John F. Snell, McGill University. Pages ix+307. 14x19 cm. Cloth. 1914. $1.25. The Macmillan Company.

News, Ads and Sales, the Use of English for Commercial Purposes, by John Baker Opclycke, Julia Richman High School, New York. Pages xiii+193. 15x21.5 cm. Cloth. 1914. $1.25. The Macmillan Company, New York.

BOOK REVIEWS.

Play and Recreation for the Open Country, by Henry S. Curtis, Lecturer on Public Recreation. Pages xvi+265. 13.5×20 cm. Cloth. 1914. $1.16. Ginn and Company, Boston.

A timely book, appealing very largely to conditions affecting the attractiveness of our country life. There is no question as to the demand, by rural communities, of a book of this character; there is no other book which handles these questions in so broad a way as does this one. It is attempted to show some ways by which the adventure and social coöperation existing among the early settlers of the country, but now so largely lost, can be brought back to meet present conditions. It contains many helpful suggestions for the organization of recreation in the rural home, in the rural school, and in the rural community. It is intended for parents, teachers and other students of rural life."

It is divided into four parts as follows: I. Play in the Home and its Environs. II. Play at the Rural School. III. Recreation in the Rural Community. IV. The Rural Social Center. The author has brought to this work a life-long experience of practical knowledge appertaining to play and recreation. It is written in a charming and entertaining way. A copy should be in the hands of all teachers, both city and country. Mechanically the volumes represent perfection in book making. C. H. S.

Farm and Gas Engines, by C. F. Hirshfeld and T. C. Ulbricht, Cornell University. Pages vii+239. 188 figures. 13.5×20 cm. Cloth. 1913. $1.50 net. John Wiley and Sons, New York City.

A book written primarily to help the farmer, or any one else for that matter, in the selection, everything considered, of that make of a gas engine best adapted to his particular needs. There is unquestionably a great need for just this kind of book. Too many purchasers of gas engines know so very little about the practical, say nothing about the theoretical, phase of these engines, that the country dealer or mail order house is enabled to sell the farmer an engine which is not at all adapted to his needs. A careful reading of this admirable book will enable the purchaser to get just the right machine for his particular work.

Only enough of the theory of the gas engine is given to enable the reader to understand the conditions which must be met in any good engine.

The strong and weak points of the various engines discussed are clearly brought out. Physics teachers can well afford to use it as a textbook when teaching this phase of their work. It is a commendable book and deserves an extensive circulation. C. H. S.

Mechanics for Builders, by Edward L. Bates and Frederick Charlesworth. Pages vii+201. 172 figures. 12.5×18.5 cm. Cloth. 1914. $1.00 net. Longmans, Green & Co., New York City.

The title of this book gives one a good idea of just what its contents consist in. It is intended for those who have not and can not obtain a knowledge of the theory of applied mechanics. The lessons are taught in many cases by discussing a concrete problem bearing on the line of work under investigation. There are many practical problems scattered throughout the book. The matter is considered under fifteen chapters. A knowledge of simple algebra and plane geometry will enable one to read the book intelligently. It is a helpful book to practical builders. C. H. S.

Gas Power, by C. F. Hirshfeld and T. C. Ulbricht, Cornell University. Pages x+209. 60 figures. 13.5×20 cm. Cloth. 1913. $1.25 net. John Wiley & Sons, New York City.

A book written with the intention of giving the reader and user of gas for power purposes a more comprehensive knowledge of the commercial importance of gas as an agent for developing power. It is easy to read and is largely free from mathematical and technical expressions beyond the ability of the student in secondary manual training and industrial schools to comprehend. It will be found a very helpful book to all who are working in this field. There are eighteen chapters, the matter in each being clearly presented. The drawings are to the point and splendidly executed. There is a very complete index of eleven pages. The book is up-to-date in every respect. It is a valuable addition to the literature of gas engineering. C. H. S.

High School Physics, by John O. Reed and William D. Henderson, University of Michigan. Pages vii+410. 13.5×19 cm. Cloth. 1913. Lyons and Carnahan, 623 S. Wabash Ave., Chicago.

This book is entirely a new creation, written by two past masters in the science and art of teaching both secondary and university physics. They have produced a text remarkably strong in all of the essentials of secondary physics. It is written in an understandable and interesting way. Its statements are accurate and altogether it is a very teachable book. It is fully adapted for use in any high school where there are either mixed or segregated classes. "It is direct in method, concise in statement, clear in illustration and practical in application." There are five hundred fifty drawings and illustrations all of which are intended to be a part of a regular recitation work. This is especially so with the three hundred line drawings. A large number of problems and exercises dealing with common everyday facts and application are given in immediate connection with proper text work.

Not the least important feature is the supplement of more than forty pages, where matter is given of "especial interest in certain localities and to individual students; discussion of modern theories; biographical sketches; table of physical constants; and supplementary problems." The book deserves an extensive adoption. C. H. S.

The Continents and Their People, South America, by James F. Chamberlain, State Normal School, Los Angeles, and Arthur H. Chamberlain, Editor Sierra Educational News. Pages ix+189. 13×19 cm. Cloth. 1913. 55 cents.

The Continents and Their People, Africa, same authors, size and price as above. The Macmillan Company, New York City.

These two books have been written in order to supplement the work and content of the regular elementary school geographies. They are written in such an easy style and made so very entertaining that the child is at once interested. They appeal very largely to the human and social conditions of the people as found in their physical and economic relations. The books are rich in the large number of photographic illustrations. These appeal directly to the child, causing him to have an increased inter-

est in his work. The type is large and clear making the books easy to read and study. There is an index and pronouncing vocabulary. These books should be in the hands of every child when he is studying geography in school. Mechanically the books are well made and intended for use.

C. H. S.

Electrical and Magnetic Calculation, by A. A. Atkinson, Ohio University. Fourth Edition Revised. Pages x+310. 13×19 cm. Cloth. 1913. $1.50 net. D. Van Nostrand Company, New York City.

In its fourth edition this splendid treatise has been brought down to the present time in every respect. Many changes and additions have been made in electrical literature since its first appearance in 1902, as far as the nature of the work in this text is concerned the matter is new from cover to cover. It is a most helpful book to electrical engineers and teachers of this phase of engineering. The book is filled with practical every-day problems, these are used to exemplify the theory. A very complete index of ten pages is given. The book deserves an increasing sale.

C. H. S.

Elements of Electricity for Technical Students, by W. H. Timbie, Pratt Institute. Pages xi+356. 411 figures. 14x20 cm. Cloth. 1914. $2.00. John Wiley & Sons, New York City.

Nothing but words of commendation should be said concerning this book. It is full of helpful, useful and teachable electrical matter from preface to index. Unquestionably it is one of the very best books, discussing this subject, which has been printed. All teachers and students of electricity are lacking an important element in securing success if they do not possess a copy of this text.

It was written primarily for the purpose of furnishing instruction and assistance to those students and industrial workers who wish to make electricity a specialty. Fundamentally it is based upon notes and outlines used in experimental and investigating ways, for several years, with the classes in the Pratt Institute. It is therefore a book from which a teacher can secure the highest efficiency with his classes. This fact alone is enough to warrant its adoption in electrical courses in all technical and trade schools. All teachers may not agree with the author in his order of treatment of subjects; this is immaterial, however, as long as correct methods of obtaining the best results are clearly given. The author does not claim to have covered the whole field of electricity but has selected a few of the most important fundamental topics and thoroughly discusses these. The methods of treatment are clear, to the point, and given in such a way as to cause the student to know that he is getting something worth while for his efforts. No knowledge of mathematics beyond common school arithmetic and first year high school algebra is necessary for an understanding of the text. The work is presented in fifteen chapters, plus an appendix of twenty pages. A complete index of eight pages is given. The numerous line drawings are splendidly executed, they could hardly be better, while the half-tones have been selected for their high illustrating effect. There are many practical problems inserted, at the right place, in the book, at the end of each chapter there is a summary of the important topics discussed in it. A list of problems on the chapter is also given.

The major paragraphs begin with bold face type while the body of the book is set in clear ten point. Mechanically the book is strongly and well made and will endure hard usage. The paper is of a high grade and not highly calendered.

C. H. S.

The Loose Leaf Laboratory Manuals, the Wiley Technical Series, J. M. Jameson, Editor. 20x26.5 cm. Paper. 1913. John Wiley and Sons, New York City.

This house has recently published a series of loose leaf manuals on several technical subjects; four of these manuals are briefly mentioned below. Under the able editorship of Mr. Jameson these manuals have been made to possess certain common and fundamental characteristics thus unifying them so that in whatever school, as a whole, they are used a uniform method of laboratory work will prevail. The various manuals have been prepared by experts in their particular line of work. The whole series bear the stamps of thoroughness, originality, practicability workableness and complete conformity to the most modern practice in laboratory work.

I. Electrical Measurements in Direct and Alternating Current by W. H. Timbie, Wentworth Institute.

This manual contains a set of instructions on how to proceed with the laboratory work. There are thirty-nine carefully selected exercises on the direct current and eleven on the alternating. The directions are clear and to the point, so written that the student will at once be able to understand them. The general description which applies to this manual is equally true in the case of each of the other three.

II. Elementary Electrical Testing, by V. Karapetoff, Cornell University.

This manual contains twenty extra practical exercises. The line drawings are exceptionally well executed. Every laboratory instructor in electrical testing cannot do better than to select this manual for his classes.

III. Exercises in Mechanics, by J. M. Jameson, Vice-President, Girard College.

There are given here fifty-two exercises making a most complete course in this phase of physics work. Many of these exercises have recently been published in this Journal. The line drawings are fine while the large number of half-tones give the student the conception as to how the apparatus is to be set up for work. The method suggested for tabulating data is exceptionally good.

IV. Exercises for the Applied Mechanics Laboratory, by John P. Kottcamp, Pratt Institute.

Here are found thirty-two exercises on work with steam, seven on the strength of materials, three on hydraulics and nine on gas engines. All of these have been selected for their special application to current industrial problems. C. H. S.

Astronomy, a Popular Handbook, by Harold Jacoby, Columbia University. Pages xiii+435. 32 plates. 124 figures. 15.5×22 cm. Cloth. 1913. $2.50 net. The Macmillan Company, New York City.

Sometimes authors of scientific books are broad-minded enough to take the reading public into their confidence, when writing texts for class room work, by presenting the matter in such a manner that the ordinary reader will be interested and at the same time able to master its contents; this, too, without in any degree lowering its standard as a class room book. The author of this book has brought about this combination in a most unusual and happy way. The book is given in two parts, the first, or major portion, of 362 pages being devoted entirely to a general discussion and explanation of astronomic phenomena. Here the subject matter is presented in such a clear, interesting and simple manner that all readers with a desire for knowledge of things astronomic are at once attracted to the book. The second part consists of a series of mathematical notes and explanations with references to the proper paragraphs in the first part of the book. There are twenty-one chapters with titles as follows: The Universe; The Heavens; How to Know the Stars; Time; The Sundial; Mother Earth; The Earth in Relation to the Sun; The Calendar; Navigation; Moonshine; The Planets; The Planets One by One; The Trades; The Solar Parallax; Astronomic Instruments; Sunshine; Eclipses; Comets;

Meteors and Aërolites; Starshine; The Universe Once More. There is a very complete index of 13 pages. This book should be in the library of every home and school. C. H. S.

The Constitution of Matter, by Joseph S. Ames, Johns Hopkins University. Pages x+242. 13x20 cm. Cloth. 1913. $1.50 net. Houghton Mifflin Company, New York City.

This volume consists of a series of six lectures delivered by the author at Northwestern University under the Norman W. Harris Lectures. The audience before whom they were delivered accounts for the very general and not very technical, yet highly scientific way in which the subject was handled. The gist of the lectures is based on the theory of atom and molecules and the properties of electrons, explaining from these how the general properties of matter may be deduced. C. H. S.

Shelter and Clothing, a Textbook of the Household Arts, by Helen Kinne and Anna M. Cooley, Columbia University. Pages xv+377. 154 figures. 13x18.5 cm. Cloth. 1913. $1.10.

Foods and Household Management, a Textbook of the Household Arts, by same author as above. Pages xiii+401. 13x19 cm. Cloth. 1914. $1.10. The Macmillan Company, New York City.

These two splendid books are intended primarily for use in high and normal school courses, they are of such a high worth, however, that they should be placed in every home in the land. That which may be said of either book, in a general way, will apply to the other. They are timely presentations of those phases of home economics and social welfare which have until comparatively recently been too long neglected. Here one finds useful, helpful suggestions about the methods of home management, economy in the purchase of food, clothing and furniture, care and repair of the home building and its furnishings, methods of sanitation, suggestions about house and room decorations and other matters of the most vital interest to the successful upbuilding and management of the ideal home in all of its various ramifications.

Each book has a complete index. They contain many practical exercises. The first has many carefully selected recipes, together with many well selected cooking exercises. No better textbooks in household arts are published. Mechanically the books are well made, paper of fine quality, type clear and illustrations well selected. C. H. S.

Commercial Education in Germany, by F. E. Farrington, Columbia University. Pages viii+258. 15x19 cm. Cloth. 1914. $1.10. The Macmillan Company, New York City.

It is a pleasure and inspiration to read such a book as this knowing that the facts and statements made are absolutely authentic. Too much literature on the educational system in Germany is afloat in this country which is not reliable. This book will be one of the means by which our educators and commercial men will, perhaps, learn that it is a crime against the best welfare of our country not to embody more fully in our educational system the best methods, in which foreign countries excel, to assist in promoting our own educational and commercial advantages. The book is the outgrowth of much study and embodies the results of investigations made recently in two trips to the principal cities of the empire. The titles of the seven chapters are as follows: Germany and Its Educational System; Lower Commercial Schoo's; Lower Commercial Schools, Program of Study; Lower Commercial Schools, Munich Commercial Continuation School; Secondary Commercial Schools; Colleges of Commerce; Conclusion. There is a very complete index of twelve pages. The diction is splendid. It makes instructive and interesting reading. All commercial teachers and live business men should read the book.

C. H. S.

DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March, June, and October issues of this journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. Names are dropped when they become a year old.

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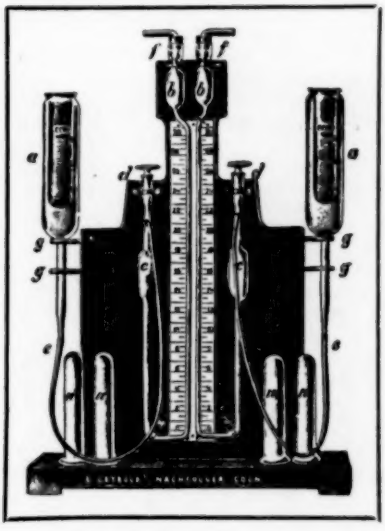

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